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# FINAL REPORT

## IDENTITY PRESERVED SYSTEMS FOR AGRI-FOOD PRODUCTS AND THE IMPACT ON THE PRESENT REGULATORY SYSTEM

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# Identity-preserving production and marketing systems in the global agri-food market: Implications for Canada

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# Abstract

This study examines the role of identity preserved production and marketing (IPPM) systems in agriculture. All the IPPM systems that have been analyzed have operated for small volume, niche market products and show that there is a cost increase of 15%-20% over the cost of conventional products. As the number of crop varieties requiring IPPM systems grow, possible as high as 30% of the market within the next decade, the structure of Canadian agriculture will have to change. On-farm quality assurance programs will be needed to ensure that Canada can continue to deliver consistently high quality grains and oilseeds.

# Identity-preserving production and marketing systems in the global agri-food market: Implications for Canada

**By Stuart Smyth and Peter W. B. Phillips**

## Executive Summary

Over the past several years, pressures on the global agri-food system to quality assure produce have increased, precipitated by food safety scares and the rapid commercialization of genetically modified (GM) products. This study focuses primarily on the impact GM varieties are having on production, marketing and supply chains in Canada and abroad.

When the European Union legislated a two year moratorium on the approval of new GM transformations and the importing of GM products, many in the industry believed that GM products would begin to flow back into Europe by 2002 or 2003 at the latest. The prevailing opinion is that while GM transformation events will be approved for research over the next few years, imported GM products would have limited access to the European market for up to a decade.

Presently over 28 countries plus the European Union system have either developed or publicly declared their intent to introduce mandatory GM labelling legislation. Canada currently exports bulk grain and oilseeds into many of these foreign markets. If Canadian exporters wish to retain these export markets as clients, then systems of identity preserved production and marketing (IPPM) will have to be established to ensure the continuity of exports to these concerned markets. Canada's advantage in the grain and oilseed export market is that foreign buyers have developed a high level of trust in the Canadian export system, due to consistent high quality commodity purchases. The advent of IPPM systems is in Canada's favour as no other country is so well positioned to take advantage of the opportunity to market crops produced using IPPM systems.

A wide range of agricultural products are presently being produced and marketed using IPPM systems. The leading GM products are canola, corn and soybeans and the leading non-GM products are organic, modified oils and high protein wheat. The overwhelming majority of segregation for GM products is occurring in North America, with limited use in South America and Australia. The largest use of IPPM systems for organics is in Europe with a growing market in North America. Virtually all of the modified oils and wheat IPPM systems are in Canada.

The cost of operating an IPPM system is estimated to be 15%-20% above the cost of moving conventional products through supply chains. This cost does not include a high level of testing for undesirable materials, which when included would raise the cost by several percentage points, nor does it include the risks of failure. These cost figures were largely derived from IPPM systems that operate for small niche market products, and there are some in the grain and biotech industry that believe that the costs are greatly underestimated as no large market IPPM system has been documented.

The governance of IPPM systems is lacking. IPPM systems can be imposed at the time of variety registration if the novel trait is deemed to harm food safety. This is done for some industrial varieties of canola. The Canadian Food Inspection Agency (CFIA) uses scientific criteria in their evaluation process and has no legal mandate from the federal government to include socio-economic or marketing factors in the decision making process. To date, the CFIA has refused to back away from science based assessment, even in the face of a potential annual market loss in the wheat industry of over $150 million, caused by the introduction of GM wheat.

IPPM systems that are properly structured and carefully administered can be effective tools for managing the risks and liabilities of segregated commodities. The importance of trust is frequently underestimated by industry when introducing new products or technologies to societies. Canada has, over time, developed a substantial level of trust in foreign markets as a country that delivers consistent high quality grain and oilseed products. Based on the success of the IPPM system that operated to segregate GM canola when it was initially commercialized, GM wheat can be commercialized and managed with the same degree of success.

This study concludes with a number of key observations and recommendations, including:

- We need a better understanding of how IPPM systems can be better structured to evolve and adapt to market needs.
- IPPM systems stand the best chance of success if they build upon credible and trusted institutions and relationships in the market (e.g. Canola Council of Canada, Canadian Wheat Board, Canadian Grain Commission and major grain companies).
- IPPM systems are only as strong as their weakest link. In the absence of regulatory action, collective efforts must be made to assure all IPPM systems deliver what they promise. This involves establishing standards and credible, third-party audit systems.
- Some elements of the currently mostly private IPPM regimes will need to be collectivized to lower costs and ensure credibility. This could involve third-party audits and organization and training for on-farm quality assurance systems.
- While most existing IPPM systems are designed to capture premiums in the market, they also offer significant potential to manage environmental risks and product liability.
- More research is needed to evaluate effectiveness of supply chains that extend beyond farm-gate and into international markets.

# Related works

## 1. Conference presentations

"The Economics of Quality Control in Agriculture." Saskatoon, Saskatchewan. December 2-4, 1999.

"Chain Management in Agribusiness and the Food Industry." Wageningen, The Netherlands. May 25-26, 2000.

4th International Conference of the International Consortium on Agricultural Biotechnology Research (ICABR), "Economics of Agricultural Biotechnology." Ravello, Italy. August 24-28, 2000.

5th International Conference of the International Consortium on Agricultural Biotechnology Research (ICABR), "Biotechnology, Science and Modern Agriculture: a New Industry at the Dawn of the Century." Ravello, Italy. June 15-18, 2001.

## 2. Publications

Smyth, S. and Phillips, P. W. B. Forthcoming. "Competitors co-operating: Establishing a supply chain to manage genetically modified canola. " *International Food and Agribusiness Management Review*. Special 2000 issue.

Smyth, S. and Phillips, P. W. B. Forthcoming. *Market Development for Genetically Modified Foods*. V. Santaniello, R. E. Evenson and D. Zilberman, eds. *Science and Regulation: Assessing the impacts of incomplete institutions and information in the global agricultural biotechnology industry*. Chapter 16. CABI Publishing.

Phillips, P. W. B. and Smyth, S., 2000. *Chain Management in Agribusiness and the Food Industry*. J. H. Trienekens and P. J. P. Zuubier eds. "Managing the value of new-trait varieties in the canola supply chain in Canada," pp. 57-65. Wageningen Pers, The Netherlands.

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# List of abbreviations

| | |
|---|---|
| AAFC | Agriculture and Agri-Food Canada |
| BSE | bovine spongiform encephalopathy |
| *Bt* | *Bacillus thuringiensis* |
| CCC | Canola Council of Canada |
| CCGD | Canadian Council of Grocery Distributors |
| CFIA | Canadian Food Inspection Agency |
| CGC | Canadian Grain Commission |
| CGSB | Canadian General Standards Board |
| CWB | Canadian Wheat Board |
| CWRS | Canadian Western Red Spring (wheat) |
| ELISA | Enzyme Linked Immunosorbant Assay |
| EPA | Environmental Protection Agency (United States) |
| EU | European Union |
| FAO | Food and Agriculture Organization |
| GIPSA | Grain Inspection, Packers and Stockyards Administration |
| GM | genetically modified |
| GMFs | genetically modified foods |
| GMOs | genetically modified organisms |
| HOC | high oil corn |
| HT | herbicide tolerant |
| IPPM | identity preserved production and marketing |
| IPRs | intellectual property rights |
| MAFF | Ministry of Agriculture, Forestry and Fisheries (Japan) |
| MPE | Manitoba Pool Elevators |
| NES | not elsewhere specified |
| nvCJD | new variant Creutzfeldt Jakob disease |
| OECD | Organization for Economic Co-operation and Development |
| OFB | Office of Food Biotechnology |
| PCR | Polymerase Chain Reaction |
| Pool | Saskatchewan Wheat Pool |
| Pools | Saskatchewan Wheat Pool, Alberta Wheat Pool and Manitoba Pool Elevators |
| QA | quality assurance |
| rbST | recombinant bovine Somatotropin |
| rDNA | recombinant DNA |
| STS | synchrony-treated soybeans |
| TUAs | Technical Use Agreements |
| UK | United Kingdom |
| US FDA | United States Food and Drug Administration |
| US | United States |
| USDA | United States Department of Agriculture |
| WCCRRC | Western Canadian Canola Rapeseed Recommendation Committee |
| WHO | World Health Organization |

# Introduction:

# Focus of the study

The purpose of this study was to address four basic questions:

- What products are presently using some form of an IPPM system?
- What costs are associated with the use of these IPPM systems?
- What governance and regulatory issues pertain to the introduction and adoption of IPPM systems?
- How can an IPPM system become an effective tool in the management of risks and liabilities for crops requiring segregation?

This study was undertaken between August 1999 and August 2001.

# Chapter 1:

# Pressures for identity preservation

## 1.1 Introduction

The introduction and rapid adoption of genetically engineered crops is rapidly changing the role of agriculture in today's marketplace. Not since the shift from horses to machinery has a technology affected agriculture like biotechnology will. It is anticipated that farms will increase in scale and become further integrated into the supply chain. As growing consumer demand drives the supply chain, producers will be required to supply increasingly differentiated products that meet this demand. The supply of these products will almost certainly be done through systems of identity preservation for all grain and oilseed types.

While segregation has a long history in Canada, markets now demand traceability, which requires identity preserving production and marketing systems. Regulatory systems in the past have managed segregation and pooling of commodities, but they are unlikely to be able to respond adequately to the increased demand for specific, timely and tailored product information. Without IPPM, Canada could lose its position as a premium agri-food exporter.

## 1.2 Evolution of segregation and identity preserved production and marketing systems

The global agri-food sector is in the initial stages of a rapid transformation. Historically, crop production has been pooled to ensure product uniformity and to realize economics in transportation and handling. Agriculture is now, however, moving toward segregated production, which will require new handling systems. The grain and oilseed industry has now progressed to the point where it segregates for organic production, speciality contracts and buyer specific purchase requirements. Plant breeding technology over the years has created a large number of varieties with input and output traits that require segregation to maintain their value. Biotechnology has further increased the number of varieties requiring segregation, which has contributed to the need to develop identity preserved production and marketing (IPPM) systems. As end users continue to refine their purchase requirements, the number of IPPM systems operating will increase and the volume these systems are capable of handling will rise. As the influence of consumer demand increases in relation to the entire food chain, IPPM systems will become commonplace in Prairie agriculture.

Segregation has been synonymous with the development of the grain handling industry in Canada. As the industry developed in Western Canada the different varieties of grain had to be separated before being railed to port. This rudimentary form of segregation evolved over time as demands for distinction between grades of grain and oilseeds developed. Presently, grain is routinely transported from the Prairies to port or end user with tolerance levels of 3% to 10% for other grain varieties. One form of segregation that has operated successfully for some time is the separation of malting barley from feed barley. Generally, malting barley is bought and sold at 95% varietal purity (Flaten, 2000).

Recently segregation has been refined and expanded as it has been transformed into identity preserved production and marketing systems. Segregation differs from IPPM in that

segregation largely involves the grain handling and transportation industries, while IPPM requires that all the participants involved in the supply chain for that crop variety and the resulting products become involved. For an IPPM system to operate effectively, seed developers, producers, grain handlers, food processors, wholesalers and retailers must be intricately involved in the design and operation of the system. IPPM systems also operate within much narrower tolerance levels than is required for varietal segregation. IPPM systems usually operate at less than 5% co-mingling and frequently at less than 1% co-mingling or adventitious admixture.

The canola industry offers an example of how IPPM systems have increased in importance and how they have been used in Canada. Over the past 30 years the canola industry in Canada has begun to specialize, with an increasing percentage of the varieties and acreage grown under managed production and marketing arrangements. Up to and including the 1999 crop year, 39 of the estimated 230 varieties registered for production in Canada exhibited some trait that either required or encouraged identify preservation efforts (Phillips and Smyth, 2000). The production and marketing arrangements vary substantially for these specialized canola varieties depending on the regulatory requirements and the market prospects for the products.

### 1.3 Reasons for identity preserved production and marketing

There are a number of reasons to develop IPPM systems, including: consumer demand; producer premiums; and regulatory requirements.

Due to previous food scares and contamination problems, European consumers have expressed great reservation about consuming products that are derived from genetically modified (GM) crops. The European Union (EU) recently developed and enacted regulations that require all raw materials and food products entering Europe with more than 1% GM content to be labelled. In response, EU processors and retailers have sought supplies that are within the tolerances, in order to avoid what is perceived as the 'stigma' of the label. This has forced North American industries that typically export products to Europe to either forgo the European marketplace or adopt IPPM systems to ensure that the end products meet European specifications. If consumer pressure to label products for GM content is successful in North America, there will need to be a large increase in the number of IPPM systems that operate world-wide.

A second reason for developing IPPM systems is to ensure that all actors in the supply chain capture the value of growing a special trait variety. If there is no system capable of measuring the attributes of value-added trait varieties, then it will be extremely difficult for companies to capture any of the attribute's value. The easier it is to identify and measure attributes, the easier it is to capture a portion of their value (Ott, 1998). These IPPM systems are typically developed for niche market products and are typified by small acreage and low volumes. Examples of this are high-oleic/low-linolenic canola, malting barley and wheat for Warburtons Ltd. (Kennett, *et al.*, 1998). All of these IPPM systems pay a premium to the producer to supply the commodity within predefined specifications. If the IPPM system did not exist, there would be no method for the producer to capture the price premium associated with the commodity. Many IPPM systems of this type operate via producer contracts that have specific conditions that must be met by the producer in order to receive the premium. These contracts are typically organized and managed by a grain company.

Identity preserved production and marketing systems can also be developed as part of a government regulatory requirement, which is necessary for getting the variety approved for commercial release. These systems are part of the variety registration process, where government regulators seek to ensure that certain novel varieties will not enter the handling system with like varieties. If these varieties were to enter the supply chain there is the potential that serious health hazards could arise, therefore the firm that wishes to receive registration of the variety has to demonstrate that there is an IPPM system developed to ensure the containment of the variety. Canadian examples include high erucic acid rapeseed and high laurate canola, as well as crops that have been modified to produce cosmetic, pharmaceutical or industrial substances (Canadian Food Inspection Agency, 1997a). Again, these IPPM systems are for small acreage and volumes. High erucic acid rapeseed, for example, accounts for between 1% - 2% of total canola production (Canadian Grain Commission, 1998).

A number of developments are increasing the pressure for new IPPM systems, including the accelerating development of new products, uncertain consumer demand, rapidly evolving rules for market access, inability to cheaply and effectively detect GM traits and declining trust in regulators.

## 1.4 Accelerating development of new products

Conventional plant breeding over the past 20 years has resulting in new varieties having speciality traits (e.g. novel oils and stronger gluten durum wheat) that command premium prices. In the late 1980s and early 1990s trait specific wheat varieties grew rapidly, from 12 potential segregations in 1985 to 68 potential segregations in 1995 (Canadian Grain Commission, 1998). With canola there were 11 high erucic acid and low linolenic/high oleic trait varieties that were required to be contract registered from 1975 to 1999 (Phillips and Smyth, 2000). These developments have led to the use of IPPM systems, albeit sparingly, over the past two decades. The recent introduction of genetically engineered crop varieties has increased pressure for more IPPM systems.

Biotechnology innovations entered global agri-food markets in 1995 with the introduction of recombinant bovine Somatotropin (rbST) and herbicide tolerant canola, corn, cotton and soybean varieties. Since then the rate of new product introductions has risen sharply, with more than 13 crops already transformed by more than 40 traits (Smyth and Phillips, 1999). James (1999 and 2000) estimates that in 2000, genetically modified crops were being produced in 14 countries on more than 44 million hectares (109 million acres) and that more than 40 new varieties involving input and output traits are in the research and development pipeline and likely will be ready for commercialization before 2005. Given the potential for stacking both input and output traits, the potential permutations and combinations leading to new products requiring IPPM systems are enormous.

The adoption rates for transgenic crops have been phenomenal. Based on global acreage, there has been a 15-fold increase from 1996 to 2000. Table 1.1 shows how dramatically the increase has been for the leading transgenic crops. If crops are required to be identity preserved solely because they are genetically engineered, managing this volume of grain and oilseed will have numerous impacts on supply chain management.

One of the larger impacts that IPPM systems will have on supply chains will be the ability of the grain industry's infrastructure to accommodate multiple systems. The Canadian grain industry is very concerned about the increase in the demand for IPPM systems. It is estimated that at present, 8-10% of production is identity preserved and within 7-10 years, this figure will rise to 25-30% (Clarkson, 1999). Bullock, *et al.*, (2000) concludes that it is not the equipment, cleaning or testing requirements of IPPM systems that will be the major cost, but rather the ability of the grain elevator system to accommodate numerous IPPM systems. With grain companies moving to large throughput elevators and rail companies preferring to run 100+ car unit trains, the infrastructure (let alone the mindset) in Western Canada is not in place that would be capable of collecting and transporting one-quarter of the crops produced on the Prairies through IPPM systems. Identity preservation and segregation of more varieties could require up to a doubling of storage capacity, which is at a premium in high throughput elevators. Research done by the United States Department of Agriculture (USDA, 2000) concluded that if the United States (US) had to export in compliance with a 1% tolerance level, transportation costs could double.

**Table 1.1: Global area (million ha) cultivated with transgenic crops**

| Crop | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|
| Soybeans | 0.5 | 5. 1 | 14.5 | 21.6* | 25.8 |
| Maize | 0.3 | 3.2 | 8.3 | 11.1 | 10.3 |
| Cotton | 0.8 | 1.4 | 2.5 | 3.7 | 5.5 |
| Rapeseed/canola | 0.1 | 1.2 | 2.4 | 3.4 | 2.8 |
| Others** | 1.1 | 1.9 | 0.1 | 0.1 | 0 |
| Total | 2.8 | 12.8 | 27.8 | 39.9 | 44.4 |

* Without transgenic soybean grown in Brazil on more than 1 million ha.
** Figures for 1998, 1999 and 2000 do not include possible acreage of transgenic tobacco in China, which amounted to more than 1 million ha in 1996 and 1997.
Sources: James, 1999 and 2000; and Huang, *et al.*, 2001.

The above scenario describes the impacts of IPPM systems on the front end of supply chains. As the products of IPPM systems move through the rest of the supply chain, additional costs will be expected. Two additional cost increases will come from labelling requirements and testing for compliance to labelling standards. However, labelling will be largely dependent on consumer acceptance of GM agri-food products. Consumer acceptance, labelling and testing are explained in greater detail in the subsequent sections.

## 1.5 Consumer acceptance of genetically modified agri-food products

A large number of consumers world-wide are or may be consuming products that contain genetically modified ingredients. Corn, soybeans and canola are extensively traded throughout the world and their processed elements are essential ingredients incorporated into an estimated 70%-85% of the processed foods on grocery store shelves. Testing for GM content in Britain has shown that unlabelled GM ingredients can be found in food products on store shelves, in spite of Britain's GM labelling legislation. Consumer attitudes and preferences about

GM products vary widely both within and between key markets, reflecting the differing views about human health, environmental safety and product quality. People with different experiences and interests have widely different perspectives on these products (Table 1.2).

| Table 1.2: Consumer attitudes to genetically modified food, 1999 | | | |
|---|---|---|---|
| **Country** | **Read or heard anything about GM foods (%)** | **Would be less likely to buy GM labelled product (%)** | **Indifferent to GM presence (%)** |
| Germany | 95 | 82 | 5 |
| U. K. | 94 | 67 | 25 |
| Japan | 89 | 70 | 23 |
| Australia | 85 | 63 | 14 |
| France | 79 | 78 | 18 |
| Canada | 78 | 68 | 28 |
| U. S. | 66 | 57 | 37 |
| Source: Globe and Mail, 2000. | | | |

These differing consumer attitudes are both a reflection of and reflected in national regulatory systems. Parallel to the introduction of these new products, government regulatory systems in key producing and consuming regions began to diverge. Canada and the US adopted regulatory standards and processes that relatively efficiently reviewed the objective, science-based risks of the products and approved products for environmental release, feed use and human consumption (Isaac and Phillips, 1999). Japan developed a comparable science-based system, which so far has delivered consistent regulatory decisions, if at times somewhat delayed from the North American schedule.

In contrast, regulatory failures in the European agri-food system heightened concerns about biotechnology-based agri-food products and destroyed confidence in existing regulatory authorities, forcing the EU to develop a new, purpose-built regulatory structure for biotechnology products. Initially this system appeared to have the potential to deliver decisions consistent with North America, but no new products have been approved since 1998 and none are likely to be approved until recently proposed revisions to the EU system are approved and enacted, now expected in 2002 or 2003. Many within the European biotechnology industry fully expect that the *de facto* moratorium on GM crop varieties could be renewed in 2002 for another three year period.

The varying levels of consumer acceptance, and the political pressures that consumers are able to apply, is a leading reason for the development of IPPM systems. Retail chains are increasingly focused on consumer preferences and thus are demanding that suppliers develop the capability to ensure product purity in the area of non-GM products. This has led to numerous IPPM systems being developed by exporting companies.

What is not clear from the surveys is whether and how much consumers value choice. The issue that arises when product labelling is discussed, is who will ultimately pay for the cost of labelling? This is especially the case when debating the issue of labelling for GM content. A survey of households (Table 1.3) in Canada (Ontario and Quebec only) and the US found that two-thirds of respondents would be willing to pay more to have GM content labelled.

| Table 1.3: Labelling for GM content: Canada versus the US | | | |
|---|---|---|---|
| Canada | | United States | |
| Cost increase | Percentage willing | Cost increase | Percentage willing |
| 5% more | 79% | $0/year | 44% |
| 10% more | 48% | $10/year | 17% |
| 20% more | 20% | $50/year | 16% |
| | | $250/year | 5% |
| | | More than $250/year | 7% |
| Sources: Angus Reid, 1999; and CSPI Poll, 2001. | | | |

There is a desire being expressed by some Canadian consumers and environmental groups to have products labelled for GM content. Frequently the critics of biotechnology state that 80-90% of consumers desire products labelled for GM content. A closer examination of the data reveals a much different story. The US poll found that only 5% of consumers would pay US$250 more per year to have products labelled for GM content whereas, in Canada 79% would pay 5% more per year for this information. Statistics Canada data that shows the average Canadian household spends C$112 a week on food (Statistics Canada, 1998). When this American figure of US$250/year is converted into Canadian dollars, it is C$375. Based on weekly food purchases, the average annual household food expense would be C$5824 of which, C$375 is 6.4%. The Canadian poll shows that 79% of consumers would be willing to pay 5% (or C$291) more to have products labelled for GM content, yet the American poll shows that only 5% of Americans would be willing to pay a comparable figure for this information. This suggests that 79% of Canadians would pay C$291 to have products labelled while only 5% of American consumers would be willing to pay the Canadian equivalent of C$375. Clearly, the difference of 74 percentage points is not due to the dollar difference of C$84. The contrast between these two figures can be attributed to the difference in the way the question was asked. The Canadian poll asked for a percentage increase, which meant that the respondents did not have to think of actual dollar costs. The American poll asked in terms of dollar cost and the respondents had to think of actual out of pocket money, thus the drastically lower percentage willing to pay for GM labelling. It would be expected that if Canadians were asked the question in terms of dollar costs, the response would be more reflective of the American results.

A report by KPMG (2000), prepared for the University of Guelph, estimates that 70-85% of all processed food products in Canada could require labels for GM content. The cost of doing this is estimated to be 35%-40% of producer price or 9%-10% of retail prices. In other words, it could cost consumers an additional C$700-$950 million per year to have processed food labelled for GM content.

A similar report by KPMG (1999), prepared for the Australia-New Zealand Food Authority, shows that Australia has about 80,000 processed food products on the market, of which 15,000 are major products and would need assessment streams for GM content labelling. The average cost per stream assessment is expected to be A$100,000, which would create an industry cost of A$1,500,000,000 or about 3% of food industry turnover. "The overall combined cost to the industry is likely to be in the range A$250,000 to A$650,000 per annum for most significant manufacturers. This translates to around A$900,000,000 per annum for the 3,000 or so significant food manufacturers and possibly around another A$5-600,000,000 for the balance

of the smaller manufacturers" (KPMG, 1999). The report concludes that it would be very unlikely that the Australian food industry would be able to accommodate a 3% cost increase without passing on the costs.

Jerome Konecsni, Chair of the Saskatchewan Nutraceutical Network and Vice-President of Bioriginal, has estimated a 3% price increase would be a competitive disadvantage for firms using GM products in the food industry (Konecsni, 1999). Based on current estimates, it would appear that all of the labelling systems would lead to larger than 3% cost increases.

## 1.6 Labelling rules for genetically modified foods

Since 1998, consumers have become increasingly concerned about the safety of genetically modified foods (GMFs). Many consumers have been unhappy with the presence of GM elements in the food system and have demanded mandatory labelling systems. A number of national governments have responded with national labelling policies. As of August 2001, 21 countries plus the European Union and a number of its member states have either adopted or announced plans to introduce labels for GMFs. These labelling regulations can be categorized as voluntary, mandatory, or mandatory above some tolerance level. Table 1.4 presents current national rules for labelling GMFs. A number of other countries have expressed interest in, or concern about, GMFs but have yet to announce whether they will impose labelling rules. For example, Turkey and Singapore are undecided.

Canada, the US, Argentina and Hong Kong have adopted a voluntary labelling strategy. Canada and the US have initiated efforts to assist industry to develop standards and to implement consistent, credible labelling systems. In September 1999, the Canadian government announced it would support efforts by the Canadian Council of Grocery Distributors (CCGD) and the Canadian General Standards Board (CGSB) to develop a Canadian standard for the voluntary labelling of GM foods. The CGSB set up a committee of food industry, producer, and consumer stakeholders, which was scheduled to report recommendations in 2000, but agreement has been delayed by the need for consensus. In the US, the United States Department of Agriculture (USDA) announced in September 1999 an independent scientific review of the biotechnology regulatory system. Public meetings, held in December 1999, highlighted public concerns about the lack of labels. In response, the USDA released "Guidance for industry: Voluntary labeling indicating whether foods have or have not been developed using bioengineering" to provide assistance to manufacturers who want to label, offering examples of acceptable and unacceptable wording. Meanwhile, in November 1999 the GE Right to Know Act (1999) was introduced in Congress. The Act would provide for mandatory labelling of GMFs. By February 2000, it had the support of 48 congressional members (equal to about 10% of voting members). One recent development has been the increase in local efforts to impose new labelling rules. As of May 2000, altogether 16 US states had introduced bills that would require labelling for GM foods (Niiler, 2000).

Meanwhile, 16 countries, plus the EU and a number of member states, have adopted or announced plans to implement mandatory labelling systems. As of August 2001, only a handful of these countries had revealed the full structure of the labelling rules they intend to pursue and only the United Kingdom (UK), Japan, China and South Korea have formally implemented labelling rules. At least five other countries have announced definite dates to implement

mandatory labelling systems. Australia and New Zealand will implement their rules in November 2001, Thailand and Brazil plan to implement labelling regulations by the end of 2001 and South Africa announced it intends to implement its labelling regulations by 2002. A number of countries have proposed mandatory labelling (e.g. Hungary, Indonesia, Poland, Russia, Switzerland, and the Czech Republic) but there is no available evidence that these countries have developed domestic systems to manage such regulations or, for that matter, any firm indication of when their systems might be operational.

Although many countries have announced plans to implement mandatory labelling, only a few have sufficiently developed their proposals enough to be able to identify the tolerance level for GM content that will trigger mandatory labelling. In order to appreciate the divergence of existing or intended labelling policies, the following sections briefly examine those systems in place or scheduled for implementation shortly.

In the EU, a number of directives set the framework for labelling systems in member states. Directive 90/220 (European Union, 1990), which is an environmental regulation (especially, Annex III), sets the basic legal framework for labelling in the EU, mandating that products that contain GM products should be labelled. Given the original environmental focus of Directive 90/220, it set down requirements for labelling of GM crop varieties in seed guides. However, it did not set tolerances for these products and varieties. It was not until 1997, when the EU Novel Foods Regulation 258/97 (European Union, 1997) was enacted that a 1% tolerance level for whole or processed foods was set. In 1998, the EU then passed Regulation 1138/98 (European Union, 1998) to cover GM varieties of corn and soybeans that were already released before Regulation 258/97 was adopted. None of these directives or regulations require labelling of GM additives, flavourings or active ingredients. Furthermore, although GM animal feed must be labelled, the meat produced using such feeds does not require labels under current rules. Finally, EU regulators have ruled that processed edible oils from GM corn, soybeans, and canola will not require labels, as they do not contain any novel proteins; all of the novel traits are left in the meal which, if consumed by humans, must be labelled. Most recently, the EU has adopted a legislative package on genetically modified organisms (GMOs) that, once implemented in October 2001, will provide rules for tracing GMOs to support the labelling rules (European Union, 2001). Given the practice of subsidiarity in the EU, European Union directives and regulations do not come into effect until member states enact such provisions in their national laws, or establish enforcement mechanisms in their jurisdictions. A number of EU member states have indicated intentions to go beyond the EU base requirements, extending labelling laws to food additives and preservatives.

So far, the UK is the only EU member state to enact national legislation and establish enforcement mechanisms to activate the EU rules. As of March 1999, all foods, additives, and flavourings that have entered the market since September 1, 1998 and that contain more than 1% GM content have been labelled. In April 2000, the new UK Food Safety Agency extended that provision to all GM foods, additives, and flavourings, including those on the market before 1998. The UK also requires that all restaurant meals with GM foods be labelled. In support of these rules, the UK has empowered the local authorities to enforce the system and adopted a range of financial penalties for mislabelling of products. This legislation has forced many British supermarkets to drop products that do not comply, thus reducing product availability for consumers. The products that can prove there is no GM content are labelled as such but

consumers pay between 10%-15% more for these products (British Broadcasting Corporation, 1999). The early indication of this legislation is that consumers have fewer food choices at higher costs.

**Table 1.4: Status of national rules for labelling GM foods.**

| States | Labels | Coverage | Effective Date |
|---|---|---|---|
| **AUSTRALASIA** | | | |
| Australia & New Zealand | M | GM content in processed foods, fruits and vegetables; 1% tolerance. | Dec. 2001 |
| **Asia** | | | |
| China | M | All foods containing GM content. | May 23, 2001 |
| Hong Kong | V/M | All foods containing GM content; 5% tolerance | Est. 2003 |
| Indonesia | M | Article 41, Provisions on Biosafety of Genetically Engineered Agricultural Biotechnology Products, requires labels | NA |
| Japan | M | MAFF regulations exempt additives, animal feeds, and any ingredient representing less than 5% of content. | April 1, 2001 |
| Russia | V | Decree No. 12 (1999) refers to labelling of GMOs | NA |
| South Korea | M | GM content for corn, soybean and bean sprouts (and potatoes in 2002) if one of top five ingredients; 3% tolerance. | March 1, 2001 |
| Taiwan | M | Processed foods containing GM corn or soybeans; 5% tolerance. | By 2005 |
| Sri Lanka | B | Currently ban production or imports of GM products. | Ongoing |
| Thailand | M | GM content in all foods and raw products; 3% or 5% tolerance. | End 2001 |
| **Africa** | | | |
| Ethiopia | M | All products. | NA |
| South Africa | M | New law proposed. | 2002 |
| **Europe** | | | |
| Austria | M | Prefer a ban on GM foods rather than labels. | NA |
| Czech Republic | M | All products of GM origin or ingredient. | NA |
| France, Ireland, Spain | M | Want to label GM additives and preservatives. | NA |
| Hungary | M | Products containing/derived from GM material (excluding feed). | NA |
| Netherlands | M | Propose mandatory labelling for animal feed. | NA |
| Poland | M | Conform to EC 219/90 and 220/90. | NA |
| Slovenia | M | Conform to EC 219/90 and 220/90. | NA |
| Switzerland | M | Conforming to EC 219/90 and 220/90. | NA |
| United Kingdom | M | Grocery store and restaurant foods on sale in UK before September 1, 1998; not for additives/flavourings/food. | March 1, 1999 |
| European Union | M | Dir. 90/220: law requiring labelling of all foods and food products containing GMOs; no tolerances set. | 1990 |
| | M | Reg. 258/97: 1% tolerances; mandatory labelling of foods; no regulation for chymosin, additives or feeds. | May 15, 1997 |
| | M | Reg. 1139/98: specific rules for GM soy and maize. | May 26, 1998 |

| North & South America | | | |
|---|---|---|---|
| Argentina | V | No required labels; voluntary labels allowed. | Ongoing |
| Brazil | B/M | Ban currently in force; propose labels with 4% tolerance. | End 2001 |
| Canada | V | Voluntary standards being developed; labels not used in interim. | 2001 or beyond |
| Mexico | M | Senate has approved a bill for GM foods to be labelled as 'transgenic' or 'made with transgenic products.' | NA |
| United States | V | GM food must be 'substantially equivalent' food. | 2001 |
| Source: Phillips and Foster, 2001. Note: B = Ban on GM products; M = Mandatory Labelling; and V = Voluntary Labelling | | | |

Japan implemented a set of mandatory labelling regulations effective April 1, 2001. As of September 2000, 29 GM crops and 6 GM food additives had secured the voluntary safety assessments in order to enter Japanese markets. From April 2001 onwards, all products are required to be assessed before they enter the market. The Ministry of Agriculture, Forestry and Fisheries (MAFF) administers the new rules that require labelling for 24 proscribed food products (no food additives are included). MAFF regulations require labels for recombinant deoxyribonucleic acid (rDNA) ingredients only if the ingredient is one of the top three food ingredients by weight and composes at least 5% of the total weight of the product. Labels are not required on packages less than 30 $cm^2$. In support of this domestic system, Japan requires importers to label as GM all bulk shipments with more than 5% GM content. Between 1% and 5% tolerances, products would have to be labelled 'may contain'. Shipments containing less than 1% GM material do not require any labelling.

Meanwhile, South Korea adopted in March 2001 rules requiring mandatory labels for any whole or processed foods containing more than 3% GM content of corn, soybean and soybean sprouts (potatoes will be added in 2002). Australia and New Zealand, via the joint Australia-New Zealand Food Standards Council, developed rules for mandatory labelling for any food, processed food, fruits and vegetables that have more than 1% GM content. The rules come into effect in December 2001. Thailand has also announced it will implement a system of mandatory labelling by the end of 2001 for all whole and processed foods containing either 3% or 5% GM content. In August 2000, two countries—Brazil and Sri Lanka—had formal bans on the production and importation of GM whole or processed foods, while a number of the EU member states have *de facto* bans in effect. There is some potential, however, that these bans may be replaced by labelling rules. Brazil, for example, has announced it plans to have a labelling system with 4% thresholds in place by the end of the year, which could enable the government to remove its block on trade and production.

Although most national labelling systems are still under development, it is apparent that there are wide divergences in the approaches taken by individual national governments that could cause trade disruptions. First, there is no consistency or consensus among national governments over the level or enforceability of tolerance levels, which could create uneven market access. Current systems range from 0% to 5%, while the range of products covered varies significantly. Second, it is not clear what labels in many jurisdictions will actually say. A variety of messages could be used, offering a range of information (e.g. 'GM ingredients',

'Warning: contains GM ingredients', or a symbol indicating the presence of GM products and ingredients), which could create technical barriers to trade. Third, labelling policies are being administered by a wide variety of governmental bodies. For example, the Agriculture Ministry is in charge in Argentina and Japan; Foreign Affairs leads in South Korea; in Canada, the Canadian Food Inspection Agency (CFIA) and Health Canada are both involved; the United States Food and Drug Administration (US FDA) leads in the US; while the Ministry of the Environment enforces UK labelling requirements. These different locations of responsibility will likely affect the orientation and procedures used to evaluate options and manage the process. Fourth, and perhaps most importantly, application of the rules varies widely. Many of the proposed labelling rules tend to focus exclusively on soybeans and corn, which together accounted for more than 80% of the global GM acreage in 1999 (James, 2000). Humans do not usually ingest GM cotton; while canola oil is deemed GM-free and most of the meal is not ingested directly by humans. This narrow commercialization is likely to change as more GM crops are brought to market. Meanwhile, only Australia, New Zealand, and the UK have proposed labelling regulations for takeaways and restaurants. Furthermore, only the UK has rules in place to require labelling of genetically modified material in food additives (e.g. chymosin in cheese; lecithin; and artificial flavours). However, the EU did recently announce that it would consider labelling for additives with detectable GM proteins. Finally, no country has yet required meats derived from animals fed on GM feeds to be labelled, although the EU is considering the need for such regulations.

There appears to be universal agreement that consumer choice needs to be enhanced through effective labelling, to allow consumers to choose between competing GM and GM-free food products. The debate is no longer about whether or not to develop a labelling system for GM foods but rather how to develop a system that provides real consumer choice without unduly interrupting international trade in agri-food products.

### 1.7 Incomplete tests for genetically modified products

When testing for GM content, there are two types of tests that can be conducted—qualitative and quantitative. Qualitative tests have the ability to detect GM content but can not determine the level of content while quantitative tests have the ability to provide accurate measures of the level of GM content.

Many have argued that all a supply chain needs to be able to do is to detect and select through testing the correct traits for specific markets. While this may work in theory, the costs, timelines and uncertainty about the current range of tests effectively eliminates this as a strategy for responding to new markets needs. In some cases traits are not detectable (e.g. organic, GM production processes after processing) while in others the tests are simply not adequate.

An example of a qualitative test is strip test form of immuno assay testing. In this test a strip is placed in a small amount of ground commodity solution and within three to five minutes, the strip indicates whether GM content is present. The cost of this rapid test is US$5 (Bullock, *et al.*, 2000).

One quantitative testing method is a herbicide tolerance bioassay test. In this test, seeds are made to germinate in the presence of a given herbicide. The test requires seven days for results at a cost of US$18 - US$40, depending on the commodity (*ibid.*). Another form of immuno assay testing is the quantitative Enzyme Linked Immunosorbant Assay (ELISA). This

test examines the proteins of a given commodity and takes a minimum of six hours to complete. This test costs about US$100 and can only test for one genetic transformation at a time. For example, this makes it very expensive to test for the 16 different GM corn transformations (*ibid.*).

The final method for testing for GM content that is commonly used is the Polymerase Chain Reaction (PCR) test. This test has the ability to be both a qualitative and quantitative test. The qualitative test costs US$205US and the quantitative test costs US$295 (*ibid.*). The tests normally take three days to one week to be completed and can only test for one genetic transfer at a time. This form of test is considered reliable at concentration levels greater than 2%. For levels between 0.5% and 2%, the reliability is considered to be low (KPMG, 1999). The Grain Inspection, Packers and Stockyards Administration (GIPSA) has recently approved the use of a sensitivity test that has the ability to test to 0.1%.

**Table 1.5: The costs and benefits of various quality tests**

| Test | Form | Traits detectable | Accuracy | Cost | Time |
|---|---|---|---|---|---|
| Immuno assay | Qualitative | Any GM trait | Yes or no | US$5 | 3-5 minutes |
| ELISA | Quantitative | One trait per test | NA | US$100 | 6 hours |
| Herbicide tolerance bioassay | Quantitative | One trait per test | NA | US$18-40 | 7 days |
| PCR | Can be both | One trait per test | > 2% | US$205-295 | 3-7 days |

Source: Authors. (Note: NA = not available)

The above tests deal with raw products. Tests that focus on processed foods are much more difficult due to the loss of proteins during processing, which are essential for testing. The US Environmental Protection Agency (EPA) conducted 74 tests of processed corn products made completely from StarLink™ corn and were unable to detect any evidence of the *Cry9c* protein (EPA, 2001). The testing process required in Britain for compliance with their strict labelling standards also demonstrates this. The cost is £117 per test. The test is qualitative and takes on average 25 days to obtain results. This is problematic as the 1% tolerance level, specified by UK legislation, will allow some GM content and when a business is notified that there is GM material in their processed food, the immediate question is about the level of GM content. One borough, Reading, conducted 52 sample tests between 1 January 1999 and June 2000 and found that about 10% of samples did not meet the requirements of the UK regulations (Pollard, 2000).

This does not include testing for genetically modified additives and enzymes that are regularly included in processed foods. The logistics and financial cost of testing for several different GM additives and/or enzymes in a processed product would likely make the final price of the products prohibitive. It is clear that the capabilities of testing lag behind that of genetic transfers. To have efficient IPPM systems, testing will have to increase the detection capabilities and at a greatly reduced cost.

While testing costs are high, failure to detect unwanted traits may be even higher. Gosnell (2001) provided some preliminary estimates of what those costs could be with the

introduction of GM wheat. The point of co-mingling determination will greatly impact the cost of detection. The closer detection is to the point of production, the lower the cost. The closer to export, the higher the cost. If co-mingling was determined on-farm or at an inland terminal, the cost would be substantially lower than if detection was made once loaded on an ocean-going vessel. The reason the cost would be lower is that the volume of co-mingled grain is lower on-farm or at the inland terminal than in an ocean-going vessel.

To illustrate this point, Gosnell assumed that there is a $10/tonne premium for a high quality wheat, which if co-mingled, would be lost. The best case scenario assumes that there is still a market for the high quality co-mingled wheat, albeit, without the premium. Gosnell concludes that with 100% detection, the best case would be if the co-mingled material was caught when a rail car is loaded, which would cost approximately $2.51/tonne. If the material was only detected when loaded on a ship, the cost could rise to $11.67/tonne. The worst case scenario assumes that co-mingling would cause the loss of both the premium and force the wheat into the feed market, at an additional loss of $75/tonne. In this case, costs would range from $21.36/tonne to $99.17/tonne.

These figures demonstrate that there will be a sizeable financial loss if co-mingling is not detected until the commodity enters the supply chain. This cost highlights the importance of ensuring that an IPPM system is not only structured properly, but it is also administered efficiently. Costs would skyrocket if co-mingling is not detected until the commodity is processed and reaches the store shelves. At this point, the product may have to be recalled and pulled off of the shelves, creating a great deal of negative publicity and possibly destroying the market for this product.

## 1.8 Trust, regulatory agencies and identity preserved production and marketing systems

While all this has been going on, the national regulatory systems have been stressed to handle the evolution of the science. Scientific studies, especially by Dr. Pusztai and Dr. Losey released in 1998 and 1999, have suggested that agricultural biotechnology might have significantly higher risks than previously anticipated. The UK and US regulatory systems responded significantly differently, partly based on the degree of public confidence in the regulators. This was not the first time the regulatory systems have been challenged. There are numerous instances in the US and Europe (and other countries as well) where safety systems have failed. In the US there have been a number of environmental failures, including the Three Mile Island nuclear accident of 1979, the environmental damage that resulted from long-term use of DDT and the pollution problem surrounding the 'Love Canal'. In Europe there have been numerous food safety failures, including the scare surrounding the use of hormones in livestock production in Italy in the 1970s, the presence of lysteria in unpasteurized cheese, the evidence of antifreeze in certain types of wine in the 1980s and the bovine spongiform encephalopathy (BSE) disaster of the 1990s. The long-term impacts of these failures of risk analysis systems have differed between Europe and the US.

The result in Europe is that the general public does not trust the institutions responsible for food safety. This lowered trust has developed over time due to previous food safety concerns and culminated with the BSE problem. In the early stages of the BSE problem the British government and scientists told consumers that beef was safe to eat and there were no concerns

regarding linkages to human illnesses. As more information became available it became clear that there were linkages to new variant Creutzfeldt Jakob disease (nvCJD) and consumers were advised not to eat beef, which only served to discredit the ability of the food safety institutes in the eyes of consumers. Europeans have developed a risk aversion when faced with the choice of consuming products when there is limited factual information.

The low level of trust that Europeans have in their food safety institutions is highlighted by recent research (Gaskell, *et al.*, 1999). This research compared sources of information regarding GM crops between Europe and America and peoples trust in those sources. The confidence of Europeans ranges as follows: environmental organizations (23%); consumer organizations (16%); farming organizations (16%); national public bodies (4%); and industry (1%). In contrast in the US, trust in the federal regulatory agencies was extremely high with the USDA at 90% and the FDA at 84%. These widely divergent levels of trust are key to understanding the differing levels of trust in federal regulatory agencies in Europe and the US.

The general populace in the US has higher levels of trust in the institutions responsible for public safety. This level of trust has been fostered by the actions that followed from the above mentioned failures. Following the Three-Mile Island nuclear accident, regulations and standards were thoroughly reviewed and revised to ensure an even greater level of safety. Much of this was conducted in public, which allowed those concerned to witness that the institutions were responding in a prudent manner to the concerns of the nation. The result of this is that the American public believes that their food-safety institutions have the ability to ensure that products in the marketplace are safe and that there is minimal risk to consumers when they purchase these products. Even so, when concern about the impact of *Bacillus thuringiensis* (Bt) corn on non-target organisms developed in 1999, the US government responded by strengthening the standards regarding planting of Bt corn. While the new rules are arguably somewhat beyond what might be needed to manage the risks, the incremental costs were controlled. The American public responded favourably to these new standards due to the high level of trust that they have in their institutions.

A key issue that is directly linked to risk is the ability of the media to present risks to the population in an accurate and responsible manner. Recently the media seems to have adopted the position that stories containing risk elements need to be sensationalized. The media in Britain has been largely anti-biotechnology, which has contributed to the cause of biotechnology critics. Even in Canada the majority of the press coverage of issues related to biotechnology has largely been negative. An interesting statistic out on Australia (Biotechnology Australia, 2000) reveals the difference between sources of information and trust in that information. A survey of 1200 people in Australia found that nearly 80% of those polled said that newspapers and magazines were their main source of information on GM foods. However when asked about preferred sources of information, newspapers were preferred by 14% and magazines by only 10%. The Internet was the leading preferred source of information at 38%.

This information is very important when IPPM systems are considered as a method for risk communication. The risks and benefits of biotechnology, GM crops and IPPM systems have been poorly communicated to date by those involved. Greater effort needs to occur to present factual information to consumers, industry and government agencies in ways that build upon existing levels of trust.

## 1.9 Possible government response

The simple solution often offered by those interested in agri-food markets is to ask the regulators to step in and solve the disconnect between products that science and farmers can produce and the traits that processors and importers want. While this might seem simple, as Canadian experience shows, it is not easily achieved. The best way to see the problem is to look at the choices Canada faced when GM canola entered the market in 1995.

In 1997 when the EU faced the decision of whether to approve GM crops for import and planting, the European food safety system had just formally acknowledged links between BSE and nvCJD. This issue so devastated the level of trust that Europeans placed in their food safety systems that the EU was forced in 1998 to ban imports and the licensing of new GM crop varieties until confidence improved. The lack of confidence that European regulators had in science based regulatory policy was clearly evident as the EU moved towards a protectionist stance relative to genetically engineered crops. The BSE/nvCJD crisis completely undermined the ability of EU officials to proceed with the introduction of a new technology that appeared to have far-reaching implications.

CFIA officials, when faced with approval for the new GM crop varieties, reacted according to their science-based approval process and allowed the new varieties to become registered for production in Canada. Both AgrEvo (now Aventis) and Monsanto received approval for registration and commercialization of GM canola varieties in March 1995 (CFIA, 1995). Following the spring planting in 1995, the Canola Council of Canada (CCC) expressed concerns to the CFIA that Canada's export ability could be damaged if GM canola was allowed to enter into the grain handling system and be exported to Europe or Japan. At the time, neither Europe or Japan had given regulatory approval for the importing of GM crop varieties.

The CCC discovered that the CFIA could do nothing to control or manage the production of GM canola because it had already approved the varieties. The only option the CCC had available was to convince the canola industry to come together and voluntarily segregate this canola until Europe and Japan decided whether to allow GM canola to be imported. This section documents why the federal government had no jurisdiction when faced with the regulation of a new technology.

In short, no government agency has the mandate to regulate the export of GM agri-food products. If one of these agencies had possessed the mandate to regulate exports, then they could have taken the initiative to develop IPPM guidelines. This lack of a government mandate created a void regarding the formulation of governance issues surrounding GM agri-food products and IPPM systems.

- Presently federal regulators do have the ability to require contract registration of new varieties where the "delivery of the resulting commodity into traditional commodity channels would cause harm to those channels" (CFIA, 1997a). Harm is defined as a biochemical or biophysical characteristic of a variety that may have an adverse effect if co-mingled with other registered varieties (CFIA, 1997b). This requires the firm seeking registration of the new variety to demonstrate that there is an IPPM system developed to manage and contain any adverse effects that may arise in the transportation of the commodity. Regulators have the mandate to require IPPM systems for health and safety reasons, however they have no mandate to require IPPM systems for export requirements.

- The Seeds Act is the Canadian legislation that regulates the release of new cereal varieties. No section of the Seeds Act defines regulations for the exporting of GM agri-food products. The CFIA is mandated to ensure that the approval of new varieties pose no environmental risk and that the new variety is safe for use in livestock feed. Nowhere, does the CFIA have the mandate to create regulations for the export of GM agri-food products. The CFIA could, in 1995, require IPPM systems for canola where traditional commodity channels may be damaged, as with industrial canola varieties. The problem with herbicide tolerant (HT) canola was that the CFIA had already approved the varieties for commercial release and did not have legislation to manage production. Thus, the CFIA had no mandate to require an IPPM system for the HT canola varieties being commercially grown in 1996.
- Health Canada has a mandate to ensure that new crop varieties are safe for human consumption, contain no toxins and do not increase allergenicity. Health Canada can not regulate beyond this mandate and thus has no capacity to require IPPM systems for HT canola as GM canola is equivalent to conventional canola in these categories.
- The Canadian Wheat Board (CWB) sets standards for the exporting of commodities under the CWB's mandate, it does not set standards for exporting canola, as canola is not under the CWB's mandate.
- The Canadian Grain Commission (CGC) sets and monitors the standards for grain trade. Their role is to certify the standards for export markets. They set standards for grain delivered to country elevators and to all the other elevators that handle grain, and monitor the quality until it is delivered to processing plants and mills or loaded onto ships. The CGC makes sure that the grain is free of pesticides, insects, mould, and anything else that might harm consumers or interfere with processing quality. The main concern of the CGC is the technical quality of the grain, which so far does not include standards for GM varieties.

The introduction in 1995 of two HT varieties of canola precipitated the first IPPM system for a GM crop in Canada. At that time and still, government agencies did not possess the mandate to develop policies that governed the exporting of GM agri-food products. There are policies that govern the approval of these varieties but not their exporting. Simply put: none of the federal government departments or agencies had the jurisdiction to develop legislation with this purpose in mind. This meant that the export regulations needed to assure foreign regulatory agencies had to be voluntarily developed by various players in the canola industry. Seed development companies, producers, grain and oilseed export companies, canola processors and the Canola Council of Canada, shared this task. This group developed a strategic alliance that allowed them to work together to address the concerns expressed by Canadian export markets.

### 1.10 Risks of not proceeding with identity preserved production and marketing systems

If the Canadian agri-food industry does not adopt more IPPM systems, two alternatives are possible.

First, the global agri-food market could continue to divide into two distinct markets with only limited interaction between the two. Some markets, such as the EU, and some food processors, have decided to forgo the technology for now, and are devoting increasing effort to

securing adequate volumes of GM-free foodstuffs to satisfy their customers. Consumers in those markets for the most part do not have any opportunity to consume GM foods, as they simply are not available. Other markets, such as in North America, have rapidly adopted the technology and for the most part do not offer a choice of GM-free food to their consumers. Trade between those two blocks has slowed dramatically in all those product markets where GM varieties are being used. As a result, Canada faces the risk of losing any markets not wishing GM foods in any product lines where GM traits are commercialized. For example, US corn exports to the EU dropped to US$175 million in 1999 from US$574 million in 1995 and soybean exports dropped to US$1.1 billion from US$2.1 billion while Canada's canola exports to the EU dropped to $8 million from $204 million (Industry Canada, 2000). Kuntz (2001) has estimated if GM wheat is introduced without an IPPM system, Canada could lose as much as $185 million per year or 70% of the annual premium it earns in the global wheat trade. Meanwhile, food processors in places like the EU have diverted their purchases to markets where GM varieties are not produced, such as northern Brazil for soybeans and Australia for canola.

A second alternative would be for companies to shelve their new technology. In Canada, GM seed potatoes were withdrawn from the market in 2001 in response to food processor concerns while the developer of GM flax announced it had deregistered the variety because the UK, which imports approximately 70% of Canadian production, has not approved the variety for import.

Neither of these alternatives is desirable. If Canada adopts the technology and loses key premium markets, much or all of the benefits of the new technologies will be offset by market losses, with producers facing the greatest losses. Similarly, if Canada forgoes productivity or quality enhancing opportunities, its producers will face even stiffer competition in the residual commodity markets (see Phillips and Khachatourians, 2001, for further discussion of this).

# Chapter 2:

# A review of past and current identity preserved production and marketing systems

## 2.1 Introduction:

This chapter offers a review of past and current IPPM systems operating in the global agri-food industry. Section 2.2 examines the history of segregation and IPPM systems operating in Canada. Section 2.3 discusses how to structure IPPM systems and presents the various IPPM system costs. Section 2.4 documents how IPPM systems can be used to ensure market access. Sections 2.5 to 2.9 presents IPPM systems that operate to export high protein wheat to Britain, for several American crops, for organic products, for StarLink™ corn and for pharmaceutical crops. Section 2.10 offers some lessons that can be gleaned from existing IPPM systems.

## 2.2 The history of identity preserved production and marketing systems in Canada

Identity preserved production and marketing systems were not created to accommodate the transportation of recently developed crop varieties; rather they have evolved from the long-term use of varietal separation and grain grading. Historically the major crops exported from the Prairies were wheat, oats and barley. Over time, numerous new crops and new varieties were developed for Prairie climates. Crops such as: corn, mustard, canary seed, flax, rapeseed, canola, soybeans, sugar beets, pulses, and sunflowers have all been modified for this region's growing season. Of all these new crops that have been introduced, canola is the leader in terms of adoption rates. Rapeseed became a crop variety in the 1940s and canola evolved as a line of rapeseed in the late 1970s (Phillips, 1999). For the 2000 crop year, canola trailed only spring wheat in terms of acres harvested. Table 2.1 shows that while cereals still dominate overall acreage, oilseeds and pulse crops have grown rapidly.

| Table 2.1: Sask. crop acreage, 1980-2000 (percentage of total cultivated land) | | | |
|---|---|---|---|
| Crop Variety | 1980 | 1990 | 2000 |
| Cereals | 90% | 85% | 65% |
| Oilseeds | 10% | 14% | 22% |
| Pulses | 0.1% | 1.3% | 12% |
| Source: Saskatchewan Agriculture and Food, 2000. | | | |

As the number of crop varieties grew, so too did the need to ensure that varietal purity was maintained. This put pressure on the grain companies as they were not structured to accommodate numerous crop varieties. Two solutions developed that addressed varietal purity: the first, was to designate specific site delivery; and second, to allow specific time periods when the commodity could be delivered. The first solution resulted in the commodity flowing to larger, modern elevators that could accommodate numerous varieties. The second led to increased on-farm storage due to the shortened delivery periods. Under this system, a commodity

sale would be arranged and as the sale date approached, grain companies would call for delivery of the commodity. This allowed for initial rudimentary IPPM systems to develop, as the commodity was received at the elevator, loaded directly onto rail cars, sent to port and loaded directly onto an ocean vessel or delivered to a processing plant.

Even though grading of commodities became more refined, end users continued to make increasingly specific purchases. A prime example of this is the identity preservation system that developed to supply wheat to Warburtons Ltd., a British bakery firm. Warburtons approached the CWB with a request to export four varieties of wheat that they felt possessed superior milling qualities. When all four varieties are combined, Warburtons purchases 200,000 tonnes of wheat annually. The wheat is grown using production contracts, which are called at various times throughout the crop year. This high quality wheat is then identity preserved as it leaves Manitoba and is transported to Britain.

Grading techniques have become increasingly refined over time, it has allowed purchasers the option of making very specific purchase demands. For example, an end user can specify the grain being purchased must have a protein level greater than $x$, moisture content less than $y$ and an impurity level of less than $z$ percent. Although grading refinements evolved, end users ultimately have required that identity preserved systems be established to supply the specific quality of grain demanded.

When the increase in varieties is combined with the improved grading techniques, the result was establishment of the initial rudimentary IPPM systems. Typically at this time, most commodities moved through the handling system at around 90% purity. As the quality of grain decreases, so does the level of varietal purity. For example, feed wheat is allowed to contain up to 10% rye, so when feed wheat is priced higher than rye, elevators buy rye from producers and blend it with feed wheat to achieve a higher profit. The grading system with one of the highest levels of variety purity is the one developed for the buying and selling of malting barley, which routinely operates at 95% purity.

Meanwhile, some identity preserving systems were mandated by regulatory requirements. Some crop varieties that are classified as possessing novel traits have the potential to damage conventional commodity channels if co-mingling occurs. These novel trait varieties can be required to be identity preserved by the CFIA. Novel trait varieties have regulations that specify how field trials are to be conducted and, once this phase is complete, another set of regulations that cover the unconfined release and variety registration process. It is at this stage that contract registration is introduced. Identity preservation systems are specifically discussed in the Seeds Regulations, Part III, Section 68, paragraph 2, subsection c states:

> where the biochemical or biophysical characteristics of a variety distinguish it from the majority of registered varieties of the same kind or species and it may have an adverse effect on the identity of those registered varieties, the registrant shall (i) establish and maintain a quality control system for the management of potentially adverse effects of the variety, including management responsibility, contract review, product identification and traceability, inspection, testing, control of non-conforming product, corrective and preventive actions, records and training of personnel, (ii) describe the quality control system in a document and submit the document and any subsequent amendments to that document to the Registrar for review and approval.... (CFIA, 1997b).

Thus, the CFIA has the power to decide that a variety seeking registration must have an IPPM system but additionally, reviews and approves the system prior to approving the variety.

## 2.3 The structure and use of identity preserved production and marketing systems in the agri-food system

An identify preserved production and marketing system is a 'closed loop' channel that facilitates the production and delivery of an assured quality by allowing traceability of a commodity from the germplasm or breeding stock to the processed product on a retail shelf (Buckwell, *et al.*, 1999; Lin, 2000). Firms achieve this by developing and adhering to strict protocols that specify production standards, provide for sampling and ensure appropriate documentation to audit the flow of product. Effective systems enable tracing back to sources of contamination, offer mechanisms to handle risks and liabilities and provide consumers with full information on the transformations the product has undertaken. IPPM systems provide a traceable 'chain of custody', in contrast to more traditional segregation systems, which distinguish products in different markets by physical characteristics (Dobson, forthcoming).

There is a wide range of IPPM systems now operating in Canada and around the world. Some extend only between the breeders and the wholesale market or processor, while others extend right up to the retailer. Their structure depends on the attribute they are trying to preserve. Some novel oils, such as low linolenic oils that are more stable in fryers, only have value at the processing level while others, such as high oleic oils, have health attributes that can be marketed to consumers. Identity preserved production and marketing systems are most important for providing information to consumers about the provenance of a product, as those attributes are not visible or detectable in the product itself.

In most cases IPPM systems involve similar features. All start with certified seed or pedigree animals that have the appropriate attributes for the targeted market. This material is transferred to farmers usually through some contractual arrangement, that often involves a bundled package of inputs, interim financing, specified agronomic practices, specified marketing options, requirements for documentation and monitoring and dispute settlement provisions. In some cases the requirements extend beyond the growing period for the product. Some product chains require prior investments (e.g. three years of chemical-free operation before they can produce organically) while others maintain contractual obligations beyond the growing period (e.g. restrictions on use of farmer-saved seed or progeny). Once delivery is triggered, most identity preserved products are handled and transported through special systems, such as in dedicated trucks to designated handlers or processors or in containers loaded on-farm. At the handler or processor, the product is segregated as necessary and moved to or used by the wholesaler, processor or retailer in a way to preserve the unique attribute valued by the market. Many of these products are marketed under labels that make specific claims (e.g. organic, ethically-produced, produced in an environmentally-safe manner, locally-produced, and GM-free), often supplemented with the use of private brands.

Quality in the agri-food sector historically has been managed and protected through a wide variety of open-access horizontal mechanisms. This has included seed registration and animal pedigree systems that evaluate and register new germplasm as stable and unique or by legally-based or trade-based product quality standards that narrow the range of acceptable traits (e.g. the standards for Canadian Western Red Spring (CWRS) wheat 13.5% protein or canola).

Increasingly, however, these systems are being supplemented, and at times supplanted, by proprietary vertical relationships. Growers' contracts, marketing arrangements, transportation transactions, manufacturer's processes, wholesale and retail alliances all impose a variety of obligations and quality standards that manage the value of the new product within the supply chain. In the absence of any generally accepted standards, the quality offered by the proprietary supply chains is only as good as the weakest link.

Table 2.2 outlines a number of documented IPPM systems operating in Canada and the US. The majority of these IPPM systems are structured to supply the European and Japanese markets with non-GM products. Some of the costs are actual measured operating cost increases, while others have been estimated. The difficulty in comparing numerous IPPM systems is that the volume of commodity moving through the various systems varies, thus the costs of operating the system can have a substantial range. The cost figures include price premiums offered to attract producers, which, depending on the crop, can dramatically affect the final cost figure. For example, there was no premium offered to producers in the Canadian GM canola IPPM system, while the American IPPM system for food soybeans has a substantial premium.

**Table 2.2: Summary of segregation and IPPM systems and costs**

| Country | Commodity | IPPM system attribute | Year | Cost ($Cdn. /t) | Source |
|---|---|---|---|---|---|
| Canada | Non-GM Canola | Free on board (FOB) Vancouver vessel; minimum | Est. | $25.90 - $30.65 | (1) |
| USA | Non-GM Soybean | FOB export position; minimum | Est. | $35.53 - $40.92 | (1) |
| USA | Non-GM Corn | Primary elevator to export elevator | Est. | $12.47 | (2) |
| USA | Non-GM Soybean | Primary elevator to export elevator | Est. | $28.54 | (2) |
| USA | Food Corn | FOB inland elevator | 1998 | $43.22 | (3) |
| USA | High Oil Corn | FOB inland elevator | 1998 | $14.01 | (3) |
| USA | Food Soybean | FOB inland elevator | 1998 | $91.58 | (3) |
| USA | STS Soybean | FOB inland elevator | 1998 | $17.99 | (3) |
| Canada | GM Canola | Direct trucking from farm to domestic processor | 1996 | $33-$41 | (4) |
| USA | Soybean | Farm loaded container shipment, in store Japan, no producer costs or testing | 2000 | $27.72 | (5) |

Sources: (1) Sparks Companies Inc., 2001; (2) Lin, 2000; (3) Bender *et al.*, 1999; (4) Smyth and Phillips, 1999; and (5) Reichert and Vachal, 2000.

The rest of this chapter examines a selection of these systems to identify common and unique attributes that contribute to their success or failure.

## 2.4 Identity preserved production and marketing systems to assure market access

Some IPPM systems have been implemented with the sole purpose of satisfying import restrictions in foreign nations. When the importing country removed the import restrictions, the IPPM system would usually cease to function. This was the case with the IPPM system that was voluntarily established by the canola industry in Western Canada for the initial introduction of HT canola. In 1995 the new HT varieties were introduced in Canada but had not received approval in Japan or the EU. If the new HT varieties were allowed to co-mingle with approved varieties, the resulting shipments to export markets would be jeopardized. Table 2.3 presents the distribution of Canadian production by consumer market. Facing that market structure and the accelerating flow of new products, Canadian companies had three options. The companies could commercialize the new varieties, co-mingle production and lose access to the EU and Japanese markets, which in 1994-5 imported 42% of the Canadian output. The companies could withhold their new varieties until they were approved in all key markets—Heller (1995) estimates that a regulatory delay of even one year decreases the rate of return on a new product by 2.8% while a two-year delay decreases it by 5.2%. Alternatively, Canadian producers and exporters could and did accept responsibility to segregate GM from traditional canola and develop a system to provide quality assurance of delivery to the key export markets and route sales of unapproved varieties to the North American market, which would involve Canadian export companies developing new systems of identity preservation production and marketing.

**Table 2.3: Canadian canola production and export destinations**

| Year | Canadian Production (000t) | % total production consumed domestically | % of production flowing to key export markets | | | |
|---|---|---|---|---|---|---|
| | | | Total | Japan | EU | US |
| 1990-1 | 3,266 | 22% | 78% | 59% | 1% | 15% |
| 1992-3 | 3,872 | 22% | 78% | 42% | 8% | 21% |
| 1993-4 | 5,480 | 16% | 84% | 33% | 17% | 24% |
| 1994-5 | 7,233 | 26% | 74% | 25% | 17% | 19% |
| 1995-6 | 6,436 | 30% | 70% | 28% | 6% | 24% |
| 1996-7 | 5,056 | 15% | 85% | 37% | 4% | 31% |
| 1997-8 | 6,266 | 16% | 84% | 30% | 1% | 33% |
| 1998-9 | 7,588 | 22% | 78% | 25% | 0% | 25% |
| 1999-00 | 8,798 | 37% | 63% | 32% | 1% | 28% |
| 2000-01 | 7,086 | 35% | 65% | 27% | 0% | 26% |

Source: Canola Council of Canada, 2001a.

Developing segregation systems is usually precipitated by consumer demands, producer liability or regulatory requirements. So far IPPM systems have been adopted for seven input trait varieties of canola in order to maintain market access in Japan. All of the systems introduced in 1995-6 were explicitly designed to maintain technical regulatory access. Neither consumer attitudes nor product liability concerns played much of a role in these systems.

Monsanto and AgrEvo (now Aventis) have been the two companies at the centre of the effort (Table 2.4). In the 1995 crop year they each introduced HT varieties in Western Canada,

initially through a seed multiplication program and then through commercial release. The 1995 harvest of approximately 30,000 acres and the 1996 harvest of approximately 240,000 acres were produced under IPPM conditions. Once market access to Japan was assured for the 1997 crop, the IPPM system was abandoned for *Brassica napus* (*B. napus*) varieties. Beginning in 1997 and continuing through the 1999 season, a number of Roundup Ready™ *Brassica rapa* (*B. rapa*) varieties were introduced under IPPM systems. In 1999 the four varieties accounted for 64,000 acres production.

| Table 2.4: Canola acreage under IPPM systems, 1995-99 | | | |
|---|---|---|---|
| Year | AgrEvo Liberty-Link™ | Monsanto Roundup Ready™ varieties | |
| | *B. napus* varieties | *B. napus* varieties | *B. rapa* varieties |
| 1995 | 25,000 | 5,000 | 0 |
| 1996 | 190,000 | 50,000 | 0 |
| 1997 | 0 | 0 | Minimal |
| 1998 | 0 | 0 | 50,000 |
| 1999 | 0 | 0 | 64,000 |
| Sources: Evans, 1999; and Saskatchewan Wheat Pool, 1997. | | | |

Cost estimates were found for two of the five IPPM systems (Table 2.5). While there is room for debate about the actual numbers, the two estimates suggest that transaction costs for the IPPM system were very high. There are five main areas where additional costs were incurred: by the producer, during transportation, by the processor, in administration and through opportunity costs.

| Table 2.5: Identified costs of 1996 IPPM system | | |
|---|---|---|
| Cost Category | AgrEvo & Manitoba Pool Elevators ($/mt) | Saskatchewan Wheat Pool ($/mt) |
| Producer on-farm costs | $1 | $1 |
| Freight Inefficiency | $5-6 | $7-10 |
| Dead Freight | $1.50-2 | $2-3 |
| Processor | $3-4 | $3-5 |
| Administration | $4 | $5 |
| Opportunity cost | $20 | $10 |
| Collective subsidy | | $5-7 |
| **Total IPP Cost** | **$34-37** | **$33-41** |
| mt = metric tonne<br>Sources: Manitoba Pool Elevators, 1996; and Saskatchewan Wheat Pool, 1997. | | |

In total, the two IPPM systems were estimated to cost $33-$41/mt. Based on the acreage involved, it is estimated that the IPPM systems adopted in 1995-6 cost between $2.8-$3.5 million for the AgrEvo based system and $750,000-$930,000 for the Monsanto based systems. All the stakeholders in the IPPM process shared these costs. The producers assumed the

identified on-farm costs and some of the increased transportation costs. Furthermore, they did not receive any price formal premium, and in some cases, were forced to take spot prices that were relatively unattractive relative to other markets. The grain companies assumed the dead freight costs, a portion of the freight inefficiency and part of the administration cost through their normal operating margins (Saskatchewan Wheat Pool, 1997). The crushers picked up most of the incremental crushing costs. The remaining costs (opportunity cost, administration and other subsidies) were divided and paid by Monsanto and AgrEvo, based on the acreage they had under cultivation. In Monsanto's case, they expensed this additional cost to research and development costs related to the development of the technology.

Many non-recoverable costs occurred in administration. The Saskatchewan Wheat Pool (Pool), for example, actively managed all of the producer contracts it had to ensure compliance with the terms and that co-mingling was avoided. In an effort to ensure the purity of the IPPM system, seed agents from AgrEvo, Monsanto and the Pool mapped all the fields in which HT canola was grown. Once harvest commenced AgrEvo, Monsanto and the Pool co-ordinated to ensure that an agent from one of the companies would be on farm during the harvest to inspect the harvested supplies, apply grain confetti and to seal the bin. The confetti had the company logo on one side and a unique grower identification number on the other. This placed a very real constraint on producers while at the same time providing the Pool marketing department with accurate information of where and how much HT canola was available. At this point, the Pool worked with the processors to arrange to have the HT canola trucked to and crushed at a designated oil crushing plant that was just about to have a scheduled shut down and cleaning. Once a crush date was determined, the Pool contracted with commercial truckers to pick up the HT canola from farmers and deliver it to the designated processors. When the canola was to be trucked, an agent from the Pool was again on farm to inspect to ensure that none of the bins had been opened or tampered with. This process was very difficult due to the simple logistics of trucking grain in the winter in Western Canada. Snowstorms, impassable roads and bad driving conditions all complicated the co-ordination of trucking process. These requirements were all labour intensive and were estimated to cost $4-$5/mt.

The total cost of the IPPM system operated in conjunction with the Saskatchewan Wheat Pool in 1995-6 was estimated to exceed $4 million. The average five-year farm-gate price for conventional canola, from 1991-96, was $280 dollars per tonne. Using the cost increase range of $33-$41, the increased cost of this IPPM system ranged from a low of 12% to a high of 15% of the average farm-gate price. For a more in-depth report on this IPPM system, see Smyth and Phillips (1999).

The results are less clear for IPPM systems for either Europe or for *B. rapa*. Given the uncertainty about Europe, the canola industry made a deliberate decision to abandon the market in 1996. The European market was not a strong export market for Canadian canola—Europe is usually self-sufficient in terms of canola production and actually exports canola when price premiums are available. The canola industry's view was that future European canola exports had limited potential so, once Japan approved GM products, the IPPM system was discontinued, thereby removing the possibility of supplying European canola markets.

Monsanto's IPPM system since 1997 for four *B. rapa* varieties has posed more difficulties. Although the logic is the same as for the *B. napus* varieties, the economics are different. *B. rapa* has taken longer to get approval because of different environmental impacts (e.g. the seed can stay in soil for up to 15 years and still germinate). As a result of the longer

approval time, and much smaller seed market (*B. rapa* was estimated to account for less than 10% of canola acreage in Western Canada in 1999) Monsanto decided to terminate its work on *B. rapa*.

While the IPPM system for HT canola was only in place for two crop years, it did prove valuable to the participants. The Pool believes that there is intellectual property value associated with this program and still refuse to divulge additional information. One valuable lesson that was learned was that the manager of the IPPM system needed to improve the tracking of the amount of seed purchased by producers and their related product. Initially end yields were not computed with the HT IPPM system and one source indicated that the system did not capture all of the canola. There was some concern that some of the producers combined small remaining amounts of HT canola with conventional canola deliveries to empty out their bins. As a result, the grain companies as managers of the IPPM systems found they had to calculate an estimate of the projected yield and compare it to the seed purchased and delivered in order to ensure that all the grain that was produced was captured by the IPPM system. This also prompted Monsanto to tighten up their Technical Use Agreements with producers growing Round-up Ready™ canola in an attempt to ensure that producers are not brown-bagging seed.

## 2. 5 Warburtons identity preserved production and marketing system

The Canadian Prairies are known as consistent producers of high-quality milling wheat. England has a long history of importing wheat from Canada and the baking firm Warburtons imports roughly 200,000 tonnes per year. Prior to the 1995 crop season, Warburtons initiated discussions with the CWB and the CGC in an attempt to ensure the purchase of superior qualities of milling wheat (Kennett, *et al.*, 1998). An agreement was reached with Manitoba Pool Elevators (MPE), now Agricore, to administer the IPPM program under the auspices of the CWB. All of the wheat that was purchased through this IPPM system was grown with the use of producer production contracts. In 1995, producers received a premium of $30/tonne (or 81¢/bu.) to compensate them for the "extra cost and effort of growing contract wheat, and to attract farmers into the program" (Kennett, 1997). The following year the premium dropped to $20/tonne (54¢/bu.). Presently, the premium remains at $20 but is now comprised of a $10 input credit with Agricore and $10 cash (Flaten, 2001). This premium is designed to compensate producers for the costs of purchasing pedigreed seed (input credit) and having to store the wheat for longer periods of time than might normally be the case (cash).

Warburtons opened a laboratory and pilot bakery in Brandon, Manitoba in 1996 in an attempt to ensure that the contracts being purchased met the quality standards demanded by the company (Kennett, 1997). The laboratory tests the quality of the wheat samples that are provided by the producers and also performs bake tests. Investment for testing whether for quality or purity, was a key component of this IPPM system. In addition to conducting their own testing, Warburtons also pays the standard CGC testing rate of $4.50/t. The CGC has the responsibility of testing and certifying all wheat exports.

The CWB played a critical role in this IPPM system because of its monopoly over wheat exports. Initially, the CWB was concerned that a system such as this would lead to the 'cherry-picking' of top quality wheat (*ibid.*). Once the volume of wheat sales was determined, the level was deemed to be of such a low volume that this concern dissipated. For its role in the exporting of this wheat, the CWB charges Warburtons an additional premium ($2-3/t grain industry

estimate, Cook, 2001) above and beyond the premium provided to producers, which is "intended to offset any additional administration or logistical costs caused by the program" (Kennett, 1997). This premium operates as a cost recovery program. The CWB incurs additional expenses to ensure that this high-quality milling wheat is exported via an IPPM system and, for this, the CWB receives a premium that covers these costs.

The costs and benefits of this IPPM system are presented in Table 2.6.

**Table 2.6: Costs and benefits of the Warburtons IPPM system**

| Participant | Costs | Benefits |
|---|---|---|
| Producers | • Purchase certified seed annually<br>• Specific crop management practices<br>• Additional paperwork | • $20/t premium<br>• Grower contract to purchase entire crop |
| CWB | • Increased administration<br>• Reduces quality of remaining wheat | • Collects premium ($2-3/t est.)<br>• Guaranteed market |
| Agricore | • Writing and monitoring contracts<br>• Liability for co-mingling<br>• Under-utilized storage space<br>• Loss of blending opportunities | • Certified seed sales<br>• Additional specified input sales<br>• Marketing opportunities<br>• Receives fee for IPPM services ($7.50-10/t est. ) |
| Warburtons | • Expenses to producers, CWB, Agricore ($29.50-33/t est.)<br>• Costly quality control program<br>• Testing lab in Manitoba | • Higher premiums on sales (45p-50p/loaf or $1-$1.10/loaf)<br>• Stable, dependable supplier<br>• Guaranteed delivery of high-quality milling wheat |

Sources: Kennett, 1997; and authors.

The combination of the three premiums that Warburtons pays is in the range of $29.50-$33/tonne (80¢-90¢/bu.). With a 10-year average price for wheat of $183/tonne, the cost of this IPPM system is 16%-18% above conventional wheat marketing costs.

The fact that this IPPM system has been in operation since 1995 would indicate that all the participants are extracting enough benefit to continue with the operation of the system. Producers continue to participate as the premium must offset the added costs of certified seed purchase costs and on-farm segregation costs. The CWB's administration costs are covered and they have a growing market that requires no marketing costs to maintain. Agricore is able to generate additional producer input sales via the contracts. While the management fee is undisclosed (estimated to be $7.50-$10/t above the standard handling tariff of $11/t), one would assume that it must provide enough compensation to Agricore to allow them to continue managing the IPPM system. [This is not necessarily always true. Beard (2001) argues, however, that the Western Canadian grain industry is facing such tremendous competitive pressure that some companies are doing things to protect producer market share and customer market share that may not be completely rational from a purely economic perspective.] Finally, Warburtons is

able to sell a superior high-quality loaf of bread in the UK at a higher price, thus justifying the producer premium, fee expenses and the costly quality assurance program they have implemented. Loaf bread in the UK is typically in the price range of 25p-30p compared to the 75p for Warburtons bread. It would appear that so far the benefits of this IPPM system have been distributed through-out the system, which ensures the future participation of all stakeholders.

## 2.6 American identity preserved production and marketing systems

The US grain system has several speciality varieties of corn and soybeans that require segregation. There has been some documented evidence of additional handling costs for high oil corn (HOC) and synchrony-treated soybeans (STS). Bender, *et al.*, 1999, provides an in-depth examination of the additional costs related to the handling of speciality crops. They surveyed over 50 grain elevators and 10 speciality grain firms in an attempt to determine what costs were related to the handling of speciality crops, namely corn and soybeans. Table 2.7 documents the additional costs determined from this study.

**Table 2.7: Comparison of additional costs incurred in handling speciality corn and soybeans**

| Cost Category | High oil corn ($US/bu.) | STS Soybeans ($US/bu.) |
|---|---|---|
| Storage | 0.01 | 0.02 |
| Handling/segregation | 0.02 | 0.06 |
| Risk management | 0.01 | 0.07 |
| Transportation | 0.00 | 0.00 |
| Analysis/testing | 0.01 | 0.01 |
| Marketing | 0.01 | 0.02 |
| Subtotal | 0.06 | 0.18 |
| Purchasing (including premium) | 0.12 | 0.15 |
| **Total** | **0.18** | **0.33** |

Source: Bender, *et al.*, 1999.

Subsequent research that Bender has been involved with (Bender and Hill, 2000 and Good, *et al.*, 2000) shows a variation in additional production and handling costs for speciality corn and soybeans. Both of the above studies focused on Illinois firms and producers. The firm results came from a survey of 1,030 grain handling locations and the producer results were obtained from 663 producer surveys. Table 2.8 shows the results from the commodities with the higher responses and commodity volumes.

Some of the higher costs can be rationalized when premiums are examined in greater detail. Premiums attract producers to speciality contracts for two reasons. The first is to offset yield drags that may occur with the speciality variety as compared to conventional varieties. Several speciality crops have been developed from a parent variety that has the specific trait but has a lower yield. The premium is necessary then to entice producers, offering compensation for the lower yield. The second reason is to compensate for the additional storage costs. Most

speciality contracts have specific delivery periods and since processing firms can not accommodate all the corn or soybeans at once, deliveries must be staggered throughout the year. This results in producers having to store the corn on-farm for greater lengths of time than compared to conventional corn. A producer with conventional corn may be able to sell his entire crop early in the crop year and as a result receives their entire net return prior to the next year's planting. Producers with speciality contracts may be required to carry over portions of their harvest into the subsequent planting season, thus not receiving their return until well after conventional producers. For this reason, premiums are used to compensate producers for the potential lost opportunity of being able to deliver their crop at an earlier date.

**Table 2.8: Additional production and handling costs for speciality corn and soybeans**

| Product | Number of observations** | | Producer costs ($US/bu.) | Marketing firm costs ($US/bu.) | Average volume/ firm (bu.) | Total additional costs* ($US/bu.) |
|---|---|---|---|---|---|---|
| | Prod. | Firms | | | | |
| High oil corn | 22 | 135 | .01 | .29 | 231,000 | .30 |
| White corn | 4 | 30 | .46 | .51 | 263,000 | .97 |
| Yellow corn | 5 | 33 | 1.21 | .19 | 494,000 | 1.41 |
| STS soybeans | 15 | 65 | .10 | .41 | 170,000 | .51 |

*Including premiums paid to producers

**Caution must be used when viewing these numbers due to the extremely low number of respondents in some categories

Sources: Bender and Hill, 2000; and Good, *et al.*, 2000.

The producer premiums for the commodities in Table 2.8 are: US$0.23/bu for high oil corn; US$0.44/bu for white corn; US$0.30/bu for yellow corn; and US$0.16/bu for STS soybeans. With speciality corns, the greater the volume, the smaller the premium is as a percentage of the total cost. Respectively, the corn premiums as a percentage of the total additional costs in Table 2.8 are 77%, 45%, and 12%. In this instance, the greater the volume, the lower the premium. This variation may be due to yield drag as the corn premiums are relatively comparable for each variety. It may also be explained by the contract requirements. The requirements for yellow corn may be greater than for high oil corn. This would result in a greater risk to the producer in meeting the contract requirements for that variety.

By far the highest cost of identity preservation for producers is the costs for yellow corn. The majority of the additional cost of US$1.21/bu. (e.g. US$1/bu) is identified as the cost of identity preservation while harvesting. While this is the average cost for harvesting corn, overall costs ranged from zero to US$5/bu. This would indicate that the exceptionally high harvesting costs are due to specificities in the production contracts. Producers also identified risk as being an important factor as they identified a cost of US$0.16/bu. associated with producing yellow corn. Again, this is an average cost, the range of costs in this category ranged from zero to US$0.50/bu. This range also supports the possibility that the greater the contract specifications, the greater the harvesting costs.

There have been several other studies that examine the economics of identity preservation (Bullock, *et al.*, 2000; Herrman, *et al.*, 1999; and Lin, 2000), however, these studies

provide constructed cost estimates of identity preservation rather than evidence from actual operational IPPM systems. Lin's paper comes the closest to using actual data as he keys off of Bender's work. The focus of Lin's paper is what costs may be expected when faced with having to segregate for non-biotech corn and soybeans. Lin estimates that segregating for non-biotech corn could add US$0.22/bu. and US$0.54/bu. for soybeans. This estimate does not include premiums paid to producers or the costs of on-farm identity preservation. As shown in the research by Bender, premiums can contribute significantly to the overall cost of identity preservation.

While the data for actual operational IPPM systems is limited, it is possible to show that the additional costs of IPPM systems can vary greatly. Again, it is important to remember that due to low respondent numbers for some of the surveys, the additional handling costs should not be accepted at face value. Rather, they should be viewed as a rough or preliminary estimate of what the true costs may actually be. The major reasons for the variation in total additional costs is the level of premium required to compensate producers and the degree of specificity required in the production contract. Some in the Canadian grain industry believe that most firms still do not have accurate data on how much it costs to handle commodity grain, let along handle identity preserved commodities. Until the grain industry is able to accurately determine these costs and share this information, all costs regarding future IPPM systems must be viewed at best as rough estimates.

## 2.7 Identity preserved production and marketing systems for organic products

The intent of this section is to analyse organic farming premiums and determine how much of the premium goes to offsetting IPPM costs. There is limited research available to provide information on organic market premiums. Most of the studies of organic agriculture focus on comparisons to conventional farming, in an attempt to determine which method provides a greater financial return. There is predominantly more literature available from US sources than Canadian.

The most comprehensive study available is a 1999 study conducted by the Henry A. Wallace Centre for Agricultural and Environmental Policy in Arlington, Virginia. This study reports that cash prices, due to premiums, for organic corn in the US were 35% above conventional corn in 1995, 44% in 1996 and 73% in 1997. Cash prices for organic soybeans for the same three-year period were more than double, nearly double and more than double (Welsh, 1999).

The only Canadian data to date is found in the *Bi-weekly Bulletin* published by Agriculture and Agri-Food Canada (AAFC). An issue from March 2000, compares a ten-year crop rotation between organic and conventional. The price comparisons reflect organic premiums for wheat and peas. The price for conventional wheat is $120/t compared to $156/t for organic wheat, a premium of 30%. The price for conventional peas is $140/t while organic peas receive a price of $210/t, for a premium of 50% (Agriculture and Agri-Food Canada, 2000).

This report on the organic industry puts the number of registered producers at 1500 across Canada, while industry experts believe it is between 800-1000. The 1999-2000 harvest produced about 140,000 tonnes of organic grain and oilseeds. Using AAFC's producers figure, the average organic producer produced about 100 tonnes. Research by Brewin (1999) presents a

typical organic rotation for black soil zones of ¼ flax, ¼ peas, ¼ wheat and ¼ clover. This would result in an average production of 33t flax, 33t peas and 34t wheat. Using AAFC's yield data it is possible to derive the acres required to obtain these levels of production. Flax requires 116.5 acres, peas require 70.9 acres and wheat 56.8 acres, for a total of 244.2 acres of organic production.

This data can then be used to derive a per tonne cost for organic certification. The 1999 inspection fees charged by Pro-Cert Organic Systems (certifies to Organic Crop Producers and Processors standards) are used to develop these figures. Using the annual farm re-inspection fee of $175 (as opposed to the initial fee of $225) and three field inspections at $25/field, the total cost for the three organic crops is $250. Using the average production acreage of 244.2, the cost of annual organic certification is $2.52/t (initial year cost would be $3.04/t). When the on-farm IPPM costs of $1/t from the 1995-96 canola IPPM system are included, the physical costs of organic IPPM would be $3.52/t. In addition to these physical costs, there would be a 'soft' cost of the time required by the producer to keep accurate records and documents detailing the IPPM system. Table 2.9 shows the premiums for organic crops as a percentage increase over conventional crop prices and what percentage of the premium is needed to off-set the organic IPPM system.

**Table 2.9: Organic IPPM costs as a percentage of organic premiums**

| Organic crop | 1998 organic premium (% increase above conventional prices) | 1998 IPPM costs (% of premium) | 1999 organic premium (% increase above conventional prices) | 1999 IPPM costs (% of premium) |
|---|---|---|---|---|
| Wheat | 25.6% | 6.64% | 28.4% | 5.87% |
| Flax | 100.6% | 1.05% | 174.6% | 0.69% |
| Peas | 98.9% | 1.93% | 103.3% | 2.24% |

Sources: Saskatchewan Agricultural and Food, 2000; and Grier, 2001.

The data in Table 2.9 shows that the cost of organic IPPM is greatest for the production of wheat, due to the low price of wheat compared to flax and peas. This shows that, although small, a portion of organic premiums are required to compensate for establishing an on-farm IPPM system.

There is insufficient data available to determine what the IPPM costs are at present past the farm-gate.

## 2.8 Identity preserved production and marketing systems for genetically modified products

There has been a great deal of discussion and speculation regarding the segregation of GM products. Much of the debate centres around whether IPPM systems for GM products will be able to function at zero or extremely low tolerance levels. Certain commodities are much better suited to be produced and handled through an IPPM system at very low tolerance levels. For example, soybeans are a closed pollinator (thus removing the possibility of cross-pollination)

and have been exported at levels approaching 100% purity. This section discusses the IPPM system that operated for StarLink™ corn in the US. This system failed and will serve to highlight some important factors that need to be addressed in designing an efficient operational IPPM system.

The most recognizable IPPM of a GM product at present is the system that was in place to prevent StarLink™ corn from entering commercial human corn channels. StarLink™ corn was developed by Aventis and had received EPA approval for animal feed use in 1998. To take advantage of market opportunities, Aventis decided to commercialize the variety, anticipating that approval for human consumption would be forthcoming shortly. But scientific tests showed that once ingested, the protein was taking longer to break down than other proteins, thus raising concerns about the potential development of allergens, and EPA delayed approval for human use.

To ensure that StarLink™ corn did not enter food corn channels, Aventis established the StarLink™ Stewardship Program. This program essentially was designed to be an IPPM system, in that the corn was to be grown under contract, with buffer zones and to be identity preserved on-farm. While the system appeared to work in theory, in practice it was a complete failure.

Problems began to emerge in the fall of 2000 when StarLink™ corn (specifically the *Cry9C* protein) was detected in processed corn products. Testing of corn products in the US showed the presence of the *Cry9C* protein which still had not been approved for human consumption. Approval for human consumption had still not been received prior to the planting of the 2000 corn crop and this served to compound the problem.

The failure of the Stewardship program would appear to be due to the inability of Aventis to ensure that all involved with StarLink™ knew that it could not enter human consumption channels. The StarLink™ technology was bred into 29 hybrids sold by 11 different seed companies (Harl, *et al.*, 2000). What has appeared to happen is that officials with Aventis failed to ensure that all the seed sales representatives from the differing seed companies attended information meetings regarding the Stewardship program. This resulted in the sales representatives putting contracts in place with producers and not informing the producers that the StarLink™ corn variety could not co-mingle with conventional varieties because it did not have EPA approval.

The 2000 StarLink™ crop accounted for 340,908 acres or 0.5% of the total US corn crop production (*ibid.*). Industry experts have estimated that the actual production may be 100,000 acres higher due to many producers being unaware of the required buffer zones. This small amount of corn that was unapproved for human consumption has had a serious negative impact on the American corn industry.

Due to the inability of American exporters to assure foreign buyers that corn shipments are free of the StarLink™ variety, sales of US corn have declined and as a result, prices are lower that they have been in over a decade. Some foreign corn buyers are turning to other markets to purchase corn. Brazil, for example, is projected to export 800,000 tonnes of corn this year. This will make Brazil a net exporter of corn for the first time in 20 years (Powell, 2001a). Frequent US corn markets are sourcing as much corn as possible from alternative markets, relying only on the US market for the remainder of their corn needs. The lowered level of exports has depressed corn prices which has negatively impacted all corn producers.

The main concern heading into the 2001 planting season is whether volunteer StarLink™ corn can be removed from bagged seed that is ready for planting. The USDA has announced that it will spend between US$15 million and US$20 million to ensure that companies inadvertently affected by StarLink™ corn are compensated (Powell, 2001b). The American corn industry has placed a great deal of pressure on the USDA to ensure that all the corn planted in the spring of 2001 has tested negative for the *Cry9C* protein, arguing that the elimination of StarLink™ corn is needed to restore confidence in US foreign corn markets.

Some of the lessons that can be learned from this IPPM system are:

- split approval between animal use and human consumption should be very tightly controlled; the EPA, in fact, recently announced that they have changed their policy on split approval, and it is no longer allowed;
- seed development firms need to ensure that all seed sales representatives have attended information events related to new varieties and thus be approved to sell new varieties;
- seed sales representatives should only be allowed to sell varieties they have been approved to sell;
- producers need to be educated about of all contract requirements; and
- a very small amount of corn can have very large financial impacts on all involved in the corn industry.

The inability of Aventis to ensure that StarLink™ corn was contained within their Stewardship program has had a far-reaching impact on the American corn industry. The total cost to Aventis has yet to be determined, but some industry officials have estimated it may reach US$2 billion. Producers, producer organizations and the state of Missouri have, among others, launched lawsuits against Aventis in an attempt to seek compensation for depressed corn prices that they claim resulted from lost foreign sales. While export markets have been negatively affected by the failure of this IPPM system, it is not known if or when they will recover. The most critical lesson is that in future IPPM of GM products will have to be well planned and logistically thought through prior to commercialization of new seed varieties.

## 2.9 Identity preserved production and marketing for pharmaceutical crops

The genetic code of canola is less complex than that of other crop varieties such as wheat or barley. For this reason, canola was the first genetically modified product to be available commercially. The structure of the genetic code of canola also allows it to be engineered to incorporate other valuable traits, such as the expression of base components of valuable pharmaceutical drugs. Scientists take genes that are responsible for expressing a drug component and insert the gene into the genetic makeup of canola and the resulting seeds then possess this trait. The cost to produce synthetic drugs can be high and this method has been proposed to be used to supply the pharmaceutical industry with a cost effective supply. Similar work is being undertaken with tobacco in the United States.

The CFIA describes new canola varieties of this type as novel trait varieties and requires that they have an IPPM system in place prior to giving approval for the release of the variety. Due to concerns about contamination, many of these varieties are grown in greenhouses and other confined environments (e.g. in abandoned mine shafts). Concern develops when

commercial application of these varieties begins. Canola pollen, for example, is very light and can travel for extended distances in the wind, thus creating the potential to cross-pollinate a crop miles away; one study detected flows of more than 30 miles. The trait may have the potential to harm or damage commercial varieties if co-mingled and allowed into the supply chain for human consumption.

Roy Button, the Executive Director of the Saskatchewan Canola Development Commission, has suggested that the prospect that these pharmaceutical varieties of canola gaining unconfined release is extremely unlikely due to the high risk of cross-pollination (Button, 2000). Tolerance levels would have to be zero for varieties of this type and to operate an IPPM system at a zero tolerance level would appear to be unattainable with the cross-pollination capability of canola. The only possibility is that a market may develop where producers could contract to grow these varieties on-farm under restricted growing conditions, such as specially designed greenhouses that ensure no pollen is allowed to escape into the surrounding environment.

Even though there is a long history of producing industrial grade rapeseed under IPPM conditions, the heightened concerns regarding pharmaceutical uses has caused SemBioSys, a Calgary based biotechnology company that pioneered this application, to decide to transfer its technology to another plant—safflower—which is not commercially produced in Western Canada.

## 2.10 Lessons from existing identity preserved production and marketing systems

This review of existing IPPM systems offers a number of lessons for both industry and government.

First, the leading feature that arises when an examination of IPPM systems occurs is that the successful systems all operate using production contracts. Grain companies, in co-operation with seed development companies, are developing producer contracts that supply the producer with the seed and chemical needed and to purchase all of the harvest. As is evidenced in the work of Bender, most of the grain handling firms also have contracts in place with processors or exporting firms. Essentially a very vertically integrated supply chain for products produced and marketed using IPPM systems is developing. As an increasing variety of commodities are produced using IPPM systems, producers will face a wide array of options that may complicate their farming operations. Industry and government may need to assist farmers to gain the expertise to properly evaluate their options.

Second, while we know that these systems are costly to develop and manage, it is not clear that the current estimates would reflect the costs of significantly expanded use of IPPM. The cost figures for IPPM systems that have been documented range between 15% and 20% above the cost of conventional products. It is crucial to remember that all of these IPPM systems have operated at low volumes—usually less than 300,000 tonnes a year—and no system to date has been documented that is operating at a substantial volume, say above one million tonnes. This has lead some, both within the biotechnology industry and academics, to suggest that the cost of operating an IPPM system at a level that has a substantial volume, have been greatly under-estimated. If this is the case, then it is questionable whether large-scale IPPM systems could achieve economies of scale that would suggest long-term use.

Third, products that require IPPM systems must earn a return high enough to justify the expense. The studies of corn and soybeans in the US and of organic crops in Canada suggests that the absolute and relative costs likely vary greatly depending on the agronomic traits of the crops, tolerances chosen and base value of the commodity crop. There are a number of examples of IPPM systems that have been established that do not earn the necessary value in the marketplace, causing the systems to be abandoned. So far all of these systems have been purpose built and rely solely on the capacity of their managers. There can and should be ways to reduce the costs of these independent systems by pooling certain activities and seeking scale economies.

Fourth, a number of the systems highlight that to succeed they not only need to cover all of the costs, but the benefits need to be distributed so that no one in the chain is worse off than they would be outside the system. This is necessary both to keep participants involved in the system but also to reduce the risk of cheating by participants that would undermine the system itself. With the approach of third generation GM crops that contain valuable output-based traits, IPPM systems will become crucial. The StarLink™ corn example highlights that an IPPM system is only as strong as its weakest link. All it takes is one participant or group becoming lax and allowing co-mingling to occur to not only destroy the IPPM system but also to inflict significantly larger costs on the marketplace. The studies suggest that while effective IPPM systems may be costly to develop and run, they are cheaper than failure.

Fifth, the on-farm assurance of crops appears to be one potential area of weakness. It certainly contributed to the StarLink™ failure and plagued the Monsanto and AgrEvo systems for canola. As more crops are contracted under IPPM, there is significant potential for conflicting and confusing information to be disseminated to producers. There is ample room for industry and government to consider how they might assist in managing this stage of the IPPM systems.

Sixth, most of the IPPM systems are not designed to operate with zero tolerance for co-mingling. Given the anticipated introduction of new value enhanced crops, either current systems need to be tightened or new systems developed in order to assure the quality, or production of those products will be restricted to non-agricultural situations and the benefits for farmers lost.

Finally, one limitation that becomes evident after analysing several IPPM systems is that virtually all of the systems are structured to operate from field to processor or export position. Further research and development is needed to understand the challenges of extending these chains both downstream from processing to the wholesale and retail stages and from export position to end consumers in foreign markets.

# Chapter 3

# A new framework for assuring product differentiation

## 3.1 Introduction:

Delivering differentiated products to the marketplace presents both quantitative and qualitative challenges. Ultimately, product differentiation involves creating and delivering quality attributes that consumers value and will pay for. Quality, however, involves objective, extrinsic, physical attributes of a product and subjective understandings and perceptions of its intrinsic features. As such, product differentiation involves the output of risk assessment and risk management and the communication of the risks and benefits to consumers. This chapter examines how quality can be developed through the risk analysis system, communicated through standards and delivered through IPPM systems.

## 3.2 Identity preserved production and marketing and quality

Ultimately, identity preservation is about quality. Quality is a multifaceted aspect for any product. Neo-classical economic theory suggests that two key elements are vital to the creation of quality: consumer tastes and preferences and producer efforts to develop consistent, safe, affordable and attractive fare that meets consumer demand. Theory suggests that most, if not all, of these elements can and should be produced within minimally regulated markets. Increasingly, however, the literature is pointing to variables of trust and confidence in the creation and operation of markets (Fukuyama, 1995 and Stiglitz, 1999). Markets for many products are often not able to create, by themselves, the conditions of trust that generate the socially optimal quantities of goods and services produced and consumed. Hence, there is a much more explicit role for public and private regulation in markets than neo-classical theory generally suggests. This is especially true for markets in transition, such as, GM agri-food products, where perceived risks and public uncertainties abound.

Tirole (1988) has explicitly identified a basis for integrating trust into conventional consumer theory. He posits that there are three types of goods: search goods, where consumers can visually identify attributes before consumption; experience goods, which require consumption to determine the attributes; and credence goods, where the unaided consumer cannot know the full attributes of consuming a good, at least for some period after consumption. Trust usually is a key element in markets involving experience and credence goods.

In practice, a single product could embody attributes that fit all three types of goods. For example, if one is looking for a tomato, one could 'search' through the bins and find one that looks good, smells ripe and is apparently free of insects or disease. Once the consumer takes it home and eats it, they experience the quality of the fruit, judging it based on a variety of subjective factors, such as the flavour and texture. Ultimately, the utility derived from that tomato includes any longer-term benefits or costs of consuming the product, which become known some time after consumption. These could include some benefits such as anti-oxidants, or some costs, such as food borne pathogens (e.g. *e-coli* or salmonella), which would become known within a few days, or toxic elements (e.g. carcinogenic elements) that may have only a long-term cumulative effect on a person's health.

Markets for search goods are for the most part able to function efficiently based on simple transactions—primitive barter economies and street markets all thrive with little or no government intervention. Markets for products which exhibit more experiential or credence factors are often unable to function without some external trust element. Experience goods, for example, usually require a greater element of trust. Product markets where there are repeated transactions, such as for haircuts or for non-durable products, often can operate with only limited regulation, either ruled by the public or private sector. Markets for experience goods with infrequent transactions (as for consumer durables such as automobiles or houses), often require some additional structures to effect the exchange (e.g. brands, warranties, regulations). Credence goods pose a much greater problem for markets. Although transactions may be possible in unregulated markets for credence goods, the absence of consumer knowledge severely limits the potential for an economically efficient outcome. These markets require some public or private regulatory structure to address the absence of consumer trust.

**Table 3.1: Product attributes and potential regulatory responses to GM plants**

| | **Search attributes** | **Experiential attributes** | **Credence attributes** |
|---|---|---|---|
| **Public role in setting rules for the transaction** | Consumer labelling laws to prevent fraud | Seeds Act regulations ensuring consistent quality | Health, safety and environmental regulations; product liability and tort laws |
| **Private mechanisms for managing the transaction** | Voluntary labelling | Trade marks backed up by IPPM systems | Private warranties and brands backed up by IPPM systems |

Source: Authors.

Applying this framework to genetically modified canola helps to illustrate how and why the agricultural industry has responded as it has to the different market circumstances. The search, experiential and credence attributes of canola have historically been assured through a combination of public and private regulatory systems (Table 3.1). In the production system, the public sector has tended to establish the general environment for private actors to effect transactions. The Canadian Food and Drugs Act set rules for human consumption of low-erucic acid canola, the Feeds Act sets maximum tolerances for glucosinolate levels, the Canada Seeds Act specifies the performance standards for new germplasm, and the Canadian Grains Commissions sets and monitors the grades for the seeds trade. Although processors can grade canola based on visual and physical attributes, such as seed weight, impurities, cracked or green seed, percentage oil content, erucic acid and glucosinolate levels, and potentially the presence of transgenes (Canbra also does some grading for GM elements), the retail consumer cannot distinguish any of the key quality differences through simple search procedures or for most attributes through consumption. At the retail level consumer labelling laws have operated to establish consistency of standards around labels. Meanwhile, the private sector has established common-property or private mechanisms to manage the transactional elements to the attributes. The Canola Council of Canada trademark on canola establishes the marketing standards for use of the name, processors have selected canola seed to meet both government and industry

standards, and the industry and private companies have used trademarks to manage their private interests. Companies employ trademarks, brands and warranties to assure customers of the value of their product.

This type of public-private regulatory structure was more or less replicated in many other producing and consuming countries. As Kennett, *et al.*, (1998) note, the existence of an effective government managed grading system (which involves managing the experiential aspects and credence risks) reduces the need for vertical co-ordination between buyers and sellers of canola. As a product with little variation in consumer preferences in most countries, there was no incentive to establish any managed production or marketing systems. Nevertheless, as Jacquemin (1987), notes, "hierarchies, federations of firms, and markets compete with each other to provide co-ordination, allocation and monitoring. It is only when one organizational form promises for specific activities a higher net return than alternative institutional arrangements that it will survive in the long run."

GM canola, for example, has introduced some differences to the system. As noted above, consumers in different markets perceive significantly different risks and have varying levels of uncertainty about the long-term benefits and costs of GM foods. All these credence factors require a much higher level of trust than the other product attributes. In Canada and the US, governments have addressed those concerns through their novel food, feed, seed and environmental regulatory systems. In addition, product liability and tort laws help to assure consumers that if dangerous products enter the food chain and cause harm, there are accessible means for consumer action to gain compensation. All of these mechanisms provide the base of 'trust' necessary for the marketplace to manage transactions, albeit moderated by extensive public and private regulatory measures. Other markets have different public institutions and hence require a different balance of public and private actors.

### 3.3 Risk management and risk communication

Economic theory has tended to ignore many of the issues related to product quality. The Marshallian demand curve is usually specified as a function of income and the product price, often supplemented with cross price elasticities for substitutes and complements. Tastes and preferences, which are fundamental factors in determining demand, are often assumed to be homogeneous and/or static.

Product quality is often ignored or assumed to be reflected in price and income elasticities. Quality of new products is especially problematic. Irrespective of the fundamental features of any new products, all new products almost by definition incorporate experiential and credence elements (Tirole, 1988), and thus trust is a vital element in creating and managing markets for those products.

Firms are often not able to create, by themselves, the conditions of trust that generate the socially optimal quantities of goods and services produced and consumed. Publicly managed risk analysis systems are vital to creating that trust. van den Daele, *et al.*, (1997) identifies three types of risk that affect the safety of product and consumer perceptions of those risks:

- Probabilistic risks involve those theoretically grounded and empirically demonstrated risks related to the product or its technology. The methods and much of the evidence is available in peer-reviewed journals or public records;

- Hypothetical risks, in contrast, involve those possibilities that are grounded in accepted theory but lack experience or empirical evidence that can establish probabilities; most of these can be identified in academic literature; and
- Speculative risks, in contrast to the other two areas, have neither established theory nor experience to back them up. Those speculative risks that have much basis can often be found in working papers or other developing literature. Beyond that, almost any correlations can be made to show the potential for risk, irrespective of whether there is any theoretical basis for the possibility.

New products can raise concerns about all three types of risk. Effective risk analysis systems encompass elements that work to assess, manage and communicate the risks to consumers and citizens:

- Risk assessment, which involves an *ex ante* evaluation of risks and benefits of GM foods, is usually based on objective examination of the science on a case by case basis;
- Risk management, which involves the human system of rules and procedures, is designed to contain products during the research and commercialization phase and undertake post-release monitoring and surveillance; and
- Risk communication, which involves dissemination of information and messages in an effort to narrow the gap between actual risks and the perceptions of risk.

As one might imagine, most risk analysis systems should be able to effectively handle risk assessment, which is relatively mechanistic. Risk management, similarly, is a fairly straightforward process. Risk communication, however, is extremely complex for issues such as genetically modified foods because of the wide array of speculative issues to which science cannot adequately respond. In absence of complete certainty about, or at least significant experience with a new technology or product, risk analysis systems must inherently be based on trust. In turn, trust is instilled as a result of reactions to risk assessments that are carried out by institutions. Trust grows as risk management procedures are adopted and refined to address public concerns. Finally, trust is firmly embedded in the public via the success of the risk communication process that develops over time. Strong institutions are crucial for successful and trustworthy food safety systems.

Frequently when food safety institutions attempt to deal with risk they adopt the approach of risk elimination, which results in costly, unnecessary regulations and/or standards. There will always be risk associated with everything individuals do. The key is to lower the level of risk until it is within an individual's comfort zone. This is the case when dealing with food safety. The utmost care is taken to ensure that products on store shelves are as safe as possible, however, there is still a minimum level of risk that must be faced when purchasing food.

Traditional risk assessment theory suggests that risk is a combined measurement of the length of exposure multiplied by the level of adverse effects of the agent to other organisms, or hazard. This can be expressed in the following formula:

RISK = HAZARD x EXPOSURE

If the time of exposure is brief (fractions of a second) and the level of hazard was a high dosage, the level of risk would be low or minimal. Science has used this formula to evaluate whether

initial research findings should proceed or be halted. If the assessment was conducted and the level of risk was determined to be high, then government agencies would not approve the initial project application or the final technology or product for release. Experts will naturally have a different view about the level of risk associated with a new product or technology than will the public. As a result, experts are often confused by consumer reactions to new products and technologies.

Sandman (1994) has argued that regulators should instead use the following formula for understanding consumer perceptions of risk:

RISK = HAZARD x OUTRAGE

Sandman believes the old formula underestimated consumers and public perceptions of risk because it ignores outrage. The public concern is focused on whether the risk is acceptable rather than on the scientific perceived level of public risk. This has important implications for risk communication, as food safety institutions must address consumer outrage in their response to the risk assessment.

Craven and Johnson (1999) in writing about food scares discuss the new approach that risk communicators must take when faced with consumer concerns.

> The science of risk communication is still relatively new, though valid and effective precepts have been clearly defined. Mitigating a hazard itself does not mitigate the outrage about the hazard. To defuse a scare, outrage must be addressed, that is, the public's particular concerns must be addressed and dealt with in a way responsive to their emotional needs regarding the issue. (Craven and Johnson, 1999)

The difficulty for risk communicators is to determine which scares, whether they are food related or not, will provoke an outrage response from consumers. It is clear that those responsible for risk communication in the biotech industry and food safety institutions were not anticipating the consumer outrage that developed in Britain and Europe following the introduction of GM agri-food products.

Snow (1997) suggests four critical elements necessary in any approach for risk communicators when dealing with consumer outrage. First, the communications must be open and fully disclose the threat and issues. Second, the communicator must acknowledge responsibility for the issue. Third, the communicator must be courteous (even if the public response is angry and impolite). Fourth, the communicator must demonstrate compassion, by respectfully recognizing and addressing people's fears and apprehensions. Failure to follow these four elements has the potential to create a high and long-lasting level of outrage within the affected community or society.

These critical elements would tend to suggest that governments and industry may need to re-evaluate their approach to dealing with food safety concerns. Historically, new food products have been introduced to the marketplace without consumer awareness and then promoted through intensive advertising campaigns. Consumers are now gaining a voice regarding the introduction of new food products and government agencies and industry have yet to respond to the greater influence of consumer associations.

## 3.4 Identity preserved production and marketing systems for risk and benefit management

This section examines how IPPM systems can contribute to risk management and risk communication in the agri-food marketplace. Supply chains for new agri-food products have been dominated by seed companies that release new improved grain and oilseed varieties and by producers rapidly adopting these new varieties. Recently, the centre of focus has shifted to the retail and consumer portion of the supply chain. Retail firms are increasingly responding to consumer desires and are striving to supply these markets. Frequently, retail firms state that their sole focus is to provide the products that consumers desire. This focus puts pressure on supply chains to source the base materials necessary to supply the demanded products.

Ultimately, the supply chain for agri-food products is moving to a system of identification and traceability. The beef industry is the leader in this area, having recently implemented a tagging system that is designed to allow for the tracing of beef products back to the producer. This system is designed to rapidly identify problems and the tagging system allows the beef industry to trace the problem to the source. Other agri-food products are expected to adopt similar identification and traceability systems.

While the Canadian food supply chain is one of the most safe and effective systems in the world today, products occasionally reach the marketplace that are not safe for human consumption. In the summer of 2000, the Costco retail chain, for instance, had a batch of ground beef that reached the store shelves that contained unsafe *e-coli* levels. Recalls were made on this product and consumers were publicly informed to return any ground beef purchased at Costco stores between specified purchase dates. The result was that very little of the product actually made its way into consumers homes. The speed at which this identification, containment and recall process operated reinforced consumers trust in the quality of the food safety system.

The food safety record in Canada, while not perfect, is among the best in the world. As such, one would not expect the introduction of new GM crop varieties into the marketplace to be a major concern as these new varieties are subject to tests and analysis above and beyond those of conventional foods. However, the introduction of new GM crops has created concern among consumers for a variety of reasons. The ag-biotech industry is trying to address these consumer concerns by increasing the information available to consumers in the hope that a better informed public will not be as opposed to ag-biotech products as an uninformed public. One way that this could be enhanced would be to document how an increase in the use of IPPM systems will improve risk management and simplify risk communication. Hepworth (forthcoming) has indicated that the Crop Protection Institute is already working with the Canadian-based biotechnology industry to implement a Biostewardship program to manage risks in the breeding, seed multiplication and production stages of the business.

Ultimately food safety concerns, at home and abroad, are going to focus on whether the products do or do not contain GM ingredients. These concerns can probably only be addressed by the establishment of a dual supply chain for agri-food products, one supplying products that contain GM ingredients and one supplying products that contain no GM ingredients. Both supply chains will have to manage and communicate risks to be successful in supplying products to their end-users. Non-GM supply chains will need to ensure that any amounts of detected GM content is below an accepted tolerance level and GM supply chains will want to protect the purity of their product when supplying niche markets.

The implementation of IPPM systems should provide the process necessary to improve risk management. For example, if a load of non-GM grain is being tested prior to being received at a grain terminal and it tests over the tolerance level for GM content, it would be rejected on the spot. The benefit for IPPM system administrators would be a system that has checks and balances in place right from the source of production. If a producer sends a sample in for testing and it shows that it does not meet tolerance levels, then this grain will never enter that IPPM system, thus simplifying risk management. Preventing unacceptable grains and oilseeds from entering the market for speciality products is the easiest way to protect the integrity of the entire IPPM system. Testing of incoming commodities establishes the documentation that allows for trust to develop in the ability of the IPPM system to supply products as specified. When a tolerance level is exceeded, the documentation will allow the system administrators to determine the source of the problem and implement an action plan to ensure that this incident is not repeated. This process simplifies risk management in that the IPPM system administrators are able to show concerned end-users that practical procedures have been developed and implemented to minimize the risk of co-mingling at every point in the supply chain.

Risk communication could also be simplified via the use of IPPM systems as the system administrators would be able to show how the standards in place are a replication of the high quality standards used for all other food products. Concerned end-users would have difficulty establishing a credible argument that the Canadian food safety system has a great deal of flaws and oversights. Enacting this enhanced quality assurance system would allow the IPPM system administrators to demonstrate that the products from non-GM and GM supply chains face standards that are higher than conventional foodstuff. Ultimately, end-users should tend to recognize the high priority that Canada places on assured quality food supply chains and corresponding high quality standards, making it easier for administrators to communicate how risks are being managed.

### 3.5 Identity preserved production and marketing and standards

Any risk analysis system will only reflect the standards that it seeks to achieve. This section of the study establishes the theoretical and practical importance of standards for identity preserved production and marketing. There is fairly clear evidence that standards are a competitive advantage that must be exploited—unlike in the past where oftentimes they were simply a way to open markets, now they are a way to control markets for commercial gain (e.g. software and food standards). The focus of this section is to identify those theoretical aspects that provide direction for the development of standards in Western Canada that could deliver competitive advantages to Canada in world markets.

In essence, commercial product standards can only really be understood in the context of all mechanisms used to manage markets (Figure 3.1). At one extreme, governments or agents for governments set regulations to achieve public goals, such as health and safety or environmental objectives. At the other extreme, private companies develop brands and provide private warranties to assure consumers of the quality of their own products. The consistent achievement of a high quality standard over a long period breeds a perception of quality, critical in the competition of knowledge-based innovative products (based on integrity and trust). Brand loyalty, a direct result of customer satisfaction, becomes a source of several long-term competitive advantages, which guarantee sufficient future demand. In particular, it:

- is the basis for line extensions, a mechanism for enhancing revenue and reducing risk by capitalizing on the perceived quality of the original product to facilitate market acceptance (Murphy 1990, Aaker, 1991, Lane and Jacobson 1995);
- increases the amount a customer will pay for a product in comparison to other comparable products, allowing for greater sales revenue through premium pricing (Keller 1993); and
- contributes to responsiveness towards marketing efforts—those with strong, favourable brand attitudes are more efficient to reach and serve (Keller 1993).

In some cases, regulations, brands or warranties can be generalized and become the commercial standard for a commodity or product group, but most commercial standards these days evolve from collective action among producers with support by government. In this in-between area, there is a role to use standards in lieu of regulations to more effectively achieve the regulatory outcome as well as a means to facilitate trade based on those product quality attributes, which are not the subject of regulatory oversight. It is important to keep the drivers for standards separate, as the first set of standards (in lieu of regulations) ultimately are driven by public-good concerns while the second set are explicitly private goods.

**Figure 3.1: Relationships between regulations, standards and private brands**

| Regulations | Standards | Private Brands |
|---|---|---|
| Regulations for public good purposes | | Private brands and Warranties |
| Driver: Public good market failures without regulation | Driver: Common pool goods requiring voice; collective rather than firm based or regulatory based | Driver: Private, firm based profit maximization |

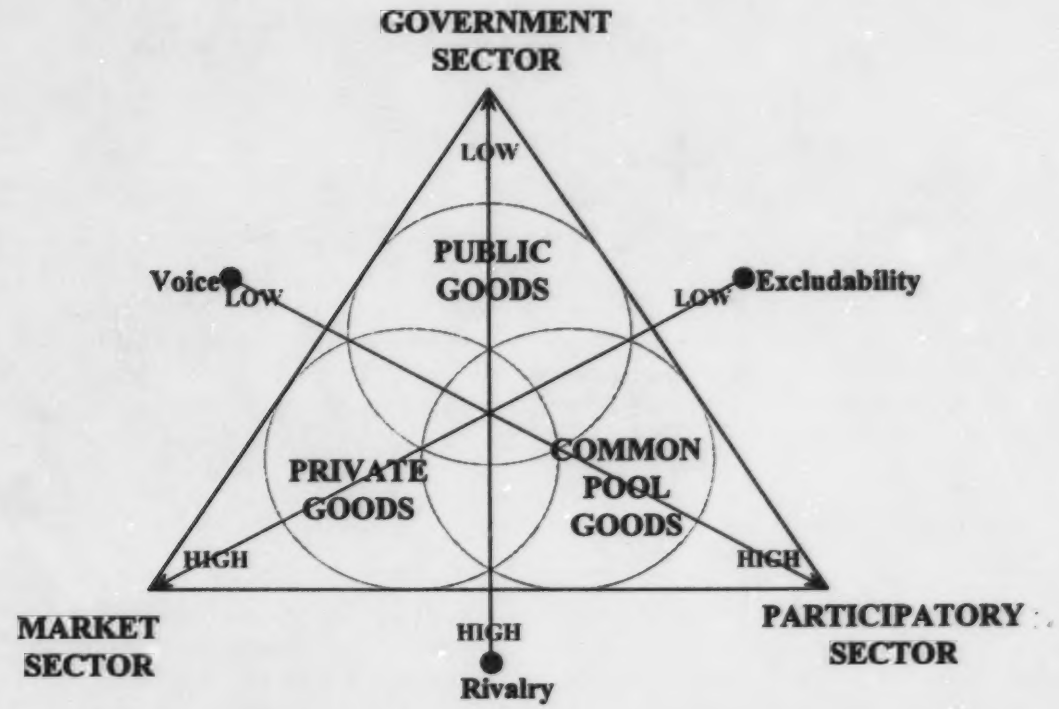
In a competitive marketplace made up of many informed buyers and sellers, market exchange is an institution that effectively governs the production and consumption of goods and services. The prices generated in a market create Adam Smith's 'invisible hand' to match the marginal cost of providing a good to the marginal value of that good to society. In a great many instances in the market place, a simple exchange of goods and services at an agreed upon price is a low-cost transaction that provides the correct incentives for the buyer and sellers. The proliferation of private brands and warranties illustrates that in some areas, the market can function.

When the marketplace operates in a manner such that the marginal social benefit is not equal to the marginal social cost of the transaction, then a market failure is said to exist. Those market failures from standard economic theory most relevant to standards are associated with public goods, common pool resources and technical externalities. Markets fail to provide

adequate public goods or common pooled goods because no one can be excluded from their consumption and, hence, there are no feasible means for a firm to charge the users for the provision of the goods. Both positive and negative technical externalities, such as knowledge or pollution, also represent market failures because they are unpriced in the market. The key factor in each of the market failures is the lack of marginal cost pricing, often due is the inability of producers to exclude consumers from using their good without paying the price.

Institutions are essential to solving market failures. They encompass a set of rules, both formal (e.g. statues) and informal (e.g. norms), which constrain the behavioural relationship among individuals or groups (North, 1991). Institutions can be established, enforced and policed either by an external authority or they can be voluntarily accepted, but the key is that they are predictable, stable, and applicable in repeated situations.

**Figure 3. 2: The nature of goods and services**




Source: Picciotto, 1995.

Particular institutions tend to be best suited to govern particular types of transactions. Picciotto (1995) classifies institutions into three general types—the government sector; the private sector; and the participatory sector. First, the government, whose stockholders are all citizens of a country, seeks to gain and maintain power, so it pursues policies (usually in the best interest of society, or at least groups in society) that contribute to re-election. Second, the private sector owns property and seeks to maximize their profit on that investment. Third, the

participation sector involves those who voluntarily join to obtain the benefits of collective action (Olson, 1965). Participants in collective ventures either seek to put forward their views and ideas or to pursue more material goals that cannot be realistically obtained through individual action. In the standards setting context, this need for 'voice' involves co-ordination among multiple actors to establish the quality attributes for products or services.

Each sector represents different individuals, involves different incentives and is effective in producing goods or attributes with specific characteristics (Table 3.2). The government sector produces public goods (e.g. public health and safety), usually characterised by low excludability,[1] low rivalry[2] and low voice,[3] that are involuntarily consumed by all citizens equally. On the other hand, the private sector provides market goods (e.g. brands and product specific warranties), that exhibit high excludability, high rivalry and low voice, and are consumed voluntarily by individuals. In contrast, the participation sector specializes in common pool goods (e.g. standards that go beyond regulations but involve more than one firm), with low excludability, from low to high rivalry and high voice (e.g. co-ordination).

**Table 3.2: Taxonomy of attributes for goods produced by different institutions**

| | Excludability | Rivalry | Voice |
|---|---|---|---|
| Government provided public goods | Low | Low | Low |
| Privately produced market goods | High | High | Low |
| Association produced collective goods | Low | Low to high | High |

Source: Gray, *et al.*, 1999.

In short, standards involve often costly investments in specific assets (the rules) but offer uncertain paybacks because of the inability to exclude others from piggy-backing on them. As a result, they depend critically on predictable, effective institutions to mobilize resources, to develop objectives and to produce benefits. It is crucial that the right institution be in place for the stage of development.

## 3.6 Conclusions

Food safety systems must be able to handle multiple risks and uncertainties that occur at multiple stages in the food system, including probabilistic, hypothetical and speculative risks. The food risk analysis system must handle those risks through assessment, management and communications. The national and international regulatory systems for biotechnology based agri-food products is incomplete (especially the risk management and communications elements) and therefore is unable to handle hypothetical and speculative risks. The absence of strong institutions to support food safety systems can lead to consumer outrage. Reassurances by government and scientists can be largely ineffective and in fact may be viewed as offensive by those concerned within society.

[1] Excludability is a circumstance where individual consumers can be excluded without incurring substantial cost.
[2] Non rival, or low substractable, goods are ones where the consumption by one person does not diminish the ability of other persons to benefit from the good.
[3] Voice is the ability of members in a sector to have their opinion heard by those who make decisions.

In short, institutions matter, especially when dealing with new products that exhibit experiential or credence features. The stronger the institution, the greater its capability to deal with incomplete information and the lower the cost of inappropriate consumer and regulatory responses.

In this day, when markets—both industry and consumers—require greater and more specific information about production processes and consumer preferences than ever before, slow and homogenous public regulations cannot adequately fill the gaps in market information. Public sector rules are fine for public good interests, such as food and environmental safety, but are too blunt an instrument to enable the private sector to meet market demand. New institutions are needed. Collective standards are one potentially useful mechanism that can tie together the production and marketing needs of emerging agri-food product lines.

Furthermore, standards delivered in the context of IPPM systems offer a competitive advantage—the information that flows between producers and consumers should facilitate trust relationships to develop, forestalling or minimizing the sense of outrage that can occur when new products are introduced. The firms or industries that are stakeholders in the supply chain can use this information to break the cycle that market advantages are short-lived. .This innovative information flow could allow firms to supply the market with continually newer and more differentiated products. Successful management of this information could allow firms to continually stay on the cutting edge of technological advancements.

The key is going to be to develop innovative standards that allow a degree of flexibility to ensure that the information that flows between firms and consumers can be used in a timely manner. Without such flexibility, niche markets either will not form in Canada or will be supplied only by larger, often non-resident, firms that can achieve economies of scale in tightly owned and operated supply chains. Either way, Canadian producers would lose an opportunity to move to higher value cropping systems.

# Chapter 4:
# The Canadian canola industry: A case study

## 4.1 Introduction

Over the past 30 years the canola industry in Canada has begun to specialize, with an increasing percentage of the varieties and acreage grown under managed production and marketing arrangements. Up to and including the 1999 crop year, 39 of the estimated 230 varieties registered for production in Canada exhibited some trait that either required or encouraged identify preservation efforts. Twelve of the 39 varieties were developed using transgenic methods. The production and marketing arrangements vary substantially depending on the regulatory requirements and the market prospects for the products.

This chapter surveys the array of new varieties being licensed and identifies and examines five separate supply chains, which have evolved. Section two discusses the scope and array of varieties that have already been released and looks at the field trial data to anticipate the potential for new varieties. Section three provides a conceptual framework for examining developments in this area. Section four compares and contrasts the five identifiable production and marketing systems. Section five examines some the implications of this analysis for the future and for other products and markets.

## 4.2 Background and circumstances

The extension of modern biotechnological techniques—e.g. genomics, marker-assisted breeding, micropropogation, cell tissue culture and transgenes—into the crop breeding industry has both accelerated new variety development and acted to encourage private investment in new differentiated product attributes. This has been visible on two levels. Many breeders adopted the techniques to develop new varieties that simply enhance the existing genetic base of crops, which has both shortened the breeding process and enhanced the targeting of effort. A wide variety of new, non-transgenic crops have flowed from this effort. Meanwhile, significant effort has been directed to developing new transgenic varieties, with commercially attractive input or output traits.

During the 1990s, the industry has had to manage the production and marketing of more than 180 new varieties (table 4.1). Between 1990 and 1999, 22 new varieties with output traits (but not involving transgenes) were introduced while approximately 135 conventional canola varieties with varying agronomic attributes targeted to specific regions and areas were launched. Then, beginning in 1995, GM canola crop varieties entered the Canadian market. Since then, the Canadian regulatory system has approved seven herbicide tolerant transgenic modifications, three transgenic hybrid modifications and two modified oils. These modifications were subsequently bred into 27 commercial varieties (Isaac and Phillips, 1999), which together accounted for approximately 62% of the Western Canadian canola acreage in 1999 (Plant Biotechnology Institute, 1999).

| Table 4. 1: Distribution of canola varieties based on traits and marketing structures, 1968-99 | | | | |
|---|---|---|---|---|
| **Category** | **No.** | **Breeders (no. of varieties)** | **Key traits (number of varieties)** | **Period** |
| Non-transgenic input traits | 180+ | Various (20+) | Basic agronomic performance | 1968-1999 |
| Transgenic input traits (not requiring contract registration) | 10 | AgrEvo (2); Plant Genetic Systems (2); Pioneer Hi-Bred (2); Limagrain (1); Univ. of Alberta (1); Zeneca (1); Alberta Wheat Pool (1) | Glyphosate tolerant/Roundup Ready™ (6); glufosinate tolerant/Liberty-Link™ (4) | 1995-1999 |
| Non-transgenic output traits (not requiring contract registration) | 16 | Intermountain Canola (7); Dow AgroSciences (2); Univ. of Manitoba (3); Limagrain (2); Pioneer Hi-Bred (1); Mycogen (1) | Speciality fatty acid not elsewhere specified (NES) (6); low linolenic (7); high oleic (2); low linolenic/high oleic (1); speciality oil NES (4); high percentage oil (1) | 1993-1999 |
| Non-transgenic output traits (requiring contract registration) | 11 | Univ. of Manitoba (9); Dow AgroSciences (1); AAFC (1) | High erucic acid (10); low linolenic/high oleic (1) | 1975-1999 |
| Transgenic output traits (requiring contract registration) | 2 | Calgene/Saskatchewan Wheat Pool (2) | High laurate (2) | 1997-1998 |
| Sources: CFIA, 1999; Canola Council of Canada, 1999; and Canola Guide, 1999. | | | | |

Meanwhile, biotechnology has accelerated the rate of development of new varieties. In the past three years an average of 30 new varieties have been introduced annually. The rapid adoption of GM varieties and the subsequent diffusion of the seed industry into a wide range of stacked input traits and differentiated novel output traits have fundamentally altered the marketing system for canola. Given that an average 75% of Western Canadian canola harvest is exported annually as seed, oil or meal, the Canadian industry cannot ignore the demands of global consumers and retailers.

The rest of this chapter examines IPPM systems for both input and output traits and identifies unique and common costs and structures of these systems. Segregation of rapeseed varieties from canola has been necessary since 1968, when the canola standard was established. Various new IPPM systems now have gone well beyond the basic structure. The traits being segregated are for the most part private, proprietary assets. The public system does not and cannot undertake the job of segregating the crop except for health and safety reasons. This paper will compare and contrast the mandated and voluntary IPPM systems for input and for output traits. To date there has been no detailed analytical research that documents the structures or costs of a comprehensive IPPM system for canola.

## 4.3 Canola production and marketing systems

Five identifiable types of supply chains are now operating in the canola industry in Canada (Table 4.2): for input traits (spot markets and voluntary general grower contracts for

both non-GM and GM input traits) and for output traits (voluntary grower contracts for non-GM output traits and mandated IPPM systems for both non-GM and GM industrial output traits).

**Table 4.2: Illustrative Examples of types of supply chains in the Canadian canola industry, 1990-99**

| | Non-GM input traits | | GM input trait | Non GM output traits | GM output trait |
|---|---|---|---|---|---|
| Regulatory base | Base is Seeds Act and Trademark | | Only base | Base plus Seeds Act Contract Registration | |
| Type | 1 | 2 | 3 | 4 | 5 |
| Illustrative variety(s) | AC-Excel | Settler | Innovator; Independence; 3850 and 3880 | DMS-100 | LA 161 LA 269 |
| Special trait | None | None | Liberty-link gene | Speciality oil | Laurate gene |
| Dates | 1991-99 | 1994-99 | 1995-6 | 1997-99 | 1997-98 |
| Marketing mechanism | Spot market | Spot market, input packages commodity futures | Management contract with Pools; grower contracts; CCC activity | Contracts with Pioneer Grain and Canbra plus grower contracts | Grower contracts |
| Seed developer | AAFC | Svalof Weibull & Pioneer Hi-Bred | AAFC and PGS for AgrEvo | Dow AgroSciences | Calgene/ Sask. Wheat Pool |
| Grain merchant | Various | Value Added Seeds | Saskatchewan, Alberta and Manitoba Pools | Pioneer Grain (JRI) | Sask. Wheat Pool |
| # Acres | ~500,000 | <200,000 | 215,000 | <150,000 | <30,000 |
| # Growers | ~5,000 | <2,000 | <2,700 | <1,000 | <300 |
| Grower premium | None | Financing | None | $40/t + $2. 50/t storage costs | $35/t |
| Transport | Growers truck to plant or elevator; grain co. manages rail | NA | Commercial trucking to plants arranged by Pools | Commercial trucking to plants arranged by Pioneer, Canbra and growers | Commercial trucking to plants arranged by Saskatchewan Wheat Pool |
| Crushers | 4 companies, 7 locations in Western Canada | NA | Canbra at Lethbridge, CanAmera at Altona and Harrowby | Canbra Foods at Lethbridge | CanAmera at Altona |
| Exporter | Various | Value Added Seeds | XCAN, not to Japan or EU | Pioneer Grain (JRI) | Calgene |

Note:t = metric tonne.

Sources: Author's estimates for AC-Excel; Allen, 1999, for Settler; K. Kennedy, 1999, for DSM-100; B. Kennedy, 1999, for AgrEvo; and Saskatchewan Wheat Pool, 1999 for LA 161.

### 4.3.1 Supply chains for input trait based canola

The three supply chains for canola with input traits operating in Canada during the 1990s are all voluntary.

The first type is based on spot markets throughout the supply chain. At root, this is a non-proprietary system, which for the most part involves public or non-proprietary varieties (e.g. AC-Excel), uses spot markets to effect the transfer of inputs and product and conforms with the public grading system established through the Seeds Act and the Canadian Grain Commission.

The second type of supply chain that has emerged during the 1990s involves a wide number of proprietary producer contract systems. In these cases, such as for the variety Settler, a grain merchant (e.g. Value Added Seeds) acquires access to a new variety that has the potential to gain market share and makes that variety available to growers only under a production input and delivery contract. In short, the grower buys a package of inputs (seed, fertilizer and herbicide) from the grain merchant, which finances the transaction until the grower delivers the resulting harvest to the merchant. The objective of this type of arrangement is to lock-in input sales and volumes. In the late 1990s, these types of contracts were worth as much as $70/acre. These contracts tended to have open-ended pricing arrangements, with provisions for growers to lock in based on futures prices. Unlike many of the other contracts in the industry, the grower obligations are limited to the specific product contracted and do not restrict in any way the production of other varieties of canola on the growers' farm. In effect, these contracts exist only where there are both corporate benefits and farmer returns.

The third system evolved in 1995 with the introduction of two HT varieties of canola. Under Canadian law new GM varieties that meet Canadian health, safety, environmental, feed and seed regulations are approved for unconfined commercial release. In 1995 Canadian approval came before the key export markets had approved the seed for importation. An earlier paper (Smyth and Phillips, 1999) documented the IPPM systems that evolved to handle the market risks of these new varieties. Between 1995 and 1999, Monsanto and AgrEvo were involved in five systems that segregated 10 GM varieties on approximately 385,000 acres.

Each of the supply chains began with a specific variety which included a proprietary herbicide tolerant gene which was backcrossed or inserted into a plant by either a contract breeder or by a partner company (e.g. AAFC, Plant Genetic Systems, University of Alberta, Alberta Wheat Pool, Limagrain, Pioneer Hi-Bred or Zeneca/Advanta). Once this variety was registered, Monsanto or AgrEvo contracted with one of the grain merchants (one of the Pools, United Grain Growers or Cargill) to manage the development and administration of an IPPM system. That company then multiplied the seed, undertook production contracts with specific farmers, arranged delivery from farms to a processor with contract truckers, and arranged for a custom crush, segregation and diversion of the resulting oil and meal into the North American market. As the objective of the IPPM system was to segregate the HT canola from traditional canola marketing channels, none of the GM canola could touch any part of the export handling system, including elevators, rail cars or port terminals. The segregated GM production was delivered to Canadian oilseed crushing plants that had markets for the oil and meal in Canada and the US, where regulatory approval had been granted (SWP, 1997). In each case, the grain

merchant acted as the operating agent for the system, managing the supply chain from seed multiplication to processing.

Although the resulting IPPM systems cost an estimated C$33-$41/tonne and the varieties did not yield any premium in the market, the participants in these IPPM systems all agreed that the herbicide resistant technology brought real value to the sector and to producers and all agreed to participate in the IPPM system in order to quickly bring the technology into the marketplace. Farmers were estimated to have earned a small increment over traditional varieties, after paying for small inefficiencies due to on-farm segregation. The grain companies and crushers estimate they were out of pocket about a few dollars per tonne, but they accepted those losses to lock in access to the new germplasm. AgrEvo and Monsanto spent C$20/tonne on the IPPM systems but gained an estimated net present value of C$100 million through accelerated adoption (Smyth and Phillips, 1999).

### 4.3.2 Supply chains for output trait based canola

The two main types of supply chains for canola with output traits operating in Canada during the 1990s were required by law. There also appear to be a few IPPM systems evolving to handle proprietary trait varieties that are not mandated but no details are available.

The fourth type of supply chain is designed to handle both commercial interests and public health and safety concerns about the novel attributes in the varieties, in order to allow the production of both food grade canola and industrial rapeseed at the same time. The fundamental driver for this system is food safety. Some products, such as high erucic acid varieties and Dow AgroSciences' DSM-100, which has low linolenic and high oleic acids, would contaminate the food chain if co-mingled and are therefore mandated by law (via Contract Registration under the Seeds Act) to be produced under IPPM rules. Dow, for instance, developed through traditional breeding processes a variety of canola that has novel oil output trait designed to meet consumer demand for an edible oil product that is low in saturated fats. They developed the seed themselves and introduced it to the marketplace in 1997 through Pioneer Grain. Dow contracted with Pioneer to multiply the seed and to introduce the seed into the market through production contracts, which for DSM-100 specified the inputs to be used, compulsory delivery, a $40/tonne premium to producers, a $2.50/tonne producer storage subsidy for late season deliveries (paid by the Japanese importer) and restrictions on other canola crops on the land. In addition, the grain merchant assembled the resulting crop, arranged its processing, and, in some cases, the export of the product. This system was explicitly designed to ensure delivery of product, which met or exceeded the end customer specifications. Although not the primary objective, the company admits that the IPPM system provides a vehicle to protect their intellectual property. The Dow system has operated for three production years and the company asserts that it has been able to both lower costs and improve efficiencies on an annual basis. Dow believes that the skills and techniques they are developing from their experiences have provided value and help to create a competitive advantage.

The fifth type of supply chain, which involves a canola variety that possesses both genetic modifications and novel industrial output traits, is similar to the fourth type. Calgene's relationship with the Saskatchewan Wheat Pool to manage the production, deliver and crushing of Laurical™ canola varieties illustrates the challenges of this type of system. As for DSM-100, laurate canola is mandated by law to be produced under an IPPM regime. But, being a 'novel

trait' variety, the seed required additional testing for environmental, food and feed safety impact compared with DSM-100, with the result that the development costs were raised. Meanwhile, laurate is a relatively low-value oil and Calgene and the Pool discovered that the sum of the $35/tonne grower premium (paid to compensate for lower yield and tight restrictions on other plantings of canola) and the incremental IPPM costs more than offset any premium for the oil, with the result that the variety was not produced in 1999.

### 4.4 Supply chain governance mechanisms

Quality in the canola industry historically has been managed and protected through a wide variety of open access horizontal mechanisms. Increasingly, however, these systems are being supplemented and at times supplanted by proprietary vertical relationships. So far the new systems have facilitated new product development, but at times in an unsustainable way.

The traditional governance system is based on an extensive horizontally based public/private regulatory system. As discussed, the Seeds Act is the first point of quality assurance, as new varieties must on average at least equal the quality of previous varieties. This is administered by the Western Canadian Canola Rapeseed Recommendation Committee (WCCRRC), a committee of more than 30 public and private breeders which evaluate new varieties against the 'check' varieties and recommend varieties for release. This standard has been backstopped by the Canola Council of Canada trademark on canola, which specifies that products must have at most 2% erucic acid and 30 micromoles of glucosinolates per 100 grams of dried meal. Furthermore, the new variety approval system periodically raises the bar for new varieties by choosing a new 'check' variety as the base for standards, which sets the base for oil and meal properties, yields and disease resistance. Once the varieties are approved, the Canadian Seed Trade Association manages the seed multiplication system, specifying the tolerances for substandard materials, and the retail seed business, by overseeing the sale of seeds by registered name. The Canola Council, the provincial growers associations and various provincial government agencies furthermore provided extensive agronomic extension advice to growers during the season. After the harvest, the CGC takes over quality assurance for much of the product, setting and enforcing grades and standards for the trade. The Canola Council of Canada, a not-for-profit industry association involving growers, grain merchants, crushers and exporters, ultimately oversees the entire system by licensing and defending its use of the canola trademark. Within this context, spot markets have relatively efficiently managed the commercialization of a large number of new varieties over the years (Kennett, *et al.*, 1998).

As the spot market has been supplanted by new vertical supply chains, quality is increasingly being managed by and for private interests. The growers' contract, which provides the base for all of these new systems, for instance, specifies a variety of obligations and quality standards that manage the value of the new product within the supply chain. This has included agronomic advice tailored to specific proprietary varieties. Meanwhile, vertical relationship extend back from the grain merchant to the seed and research companies and, in some instances, forward from the crusher into the processed foods sector. This trend has been supported with recent changes in the Canadian regulatory system, which allows for accelerated contract registration for new proprietary novel-trait varieties without going through full review by the WCCRRC.

As new proprietary supply chains have proliferated, a number of difficulties have surfaced. In interviews, company officials note that there is a critical need to have the ability to rapidly analyze grower deliveries at the consolidation point to ensure the product meets specifications and prevents co-mingling of materials. Given the traits involved, the companies are unable to adequately assure quality. Furthermore, there needs to be more capability to segregate various products into more manageable and cost effective units; most companies agree that many of the new products possible cannot be justified if the segregation system continues to cost up to C$40/tonne. The majority of the new structures being developed (both elevator buildings and handling systems) are not cost efficient in handling small-lot, non-commodity movements. Farmer extension also remains a challenge. Teaching growers to have a 'quality mindset' versus a 'quantity mindset' is a key challenge in agriculture. Although the information required to assist farmers with growing specific varieties is often only available from the research companies, the focus on quality requires some horizontal effort. Finally, it is interesting to note that so far industry based quality assurance has been very limited. Apart from the role of the Canola Council in assuring Japanese customers of the integrity of the AgrEvo/Monsanto IPPM systems in 1995-99 (Smyth and Phillips, 1999), there has been no focused effort on developing common quality assurance systems.

### 4.5 Lessons from the canola industry

Biotechnology innovations in agriculture present a clear challenge to the traditional marketing system. Transactions for new, proprietary, novel-trait canola varieties require a more extensive set of institutions than for traditional commodity varieties. Companies, assisted by governments and industry associations, have developed IPPM systems that handle both the risks and assist with capturing the returns from the introduction of new products with commercially valuable input and output traits. Spot markets for canola are increasingly competing with proprietary vertically integrated supply chains. The optimal structure and organization of these new supply chains has not evolved yet, but over time one would expect a more stable set of relationships to emerge.

IPPM systems would appear to have become a significant, permanent feature in the canola industry. If they are to remain relevant, however, they will need to become more efficient. IPPM systems appear to be technically feasible for smaller units of production but it is unclear that they are economically viable either in the long-term or for larger scale operations. Some stakeholders believe that if an IPPM system were spread over a much larger production, efficiencies would be possible while others believe that there are too many supply constraints (e.g. trucking and storage) for it to work. If IPPM systems continue to cost C$30-$40/tonne, investment in input traits could wane and the effort devoted to seeking output traits could shift to only higher value attributes that will have limited impact on overall grower profitability.

So far all of the IPPM systems developed have been custom built to meet the specifications of the technology owner and the market. The limited horizontal co-ordination between the systems has come through the seed companies (e.g. Monsanto and AgrEvo) working with their agents (the grain companies) and through the Canola Council's efforts in export markets. For the most part the grain companies have viewed the IPPM systems as valuable proprietary services. Ultimately, however, these systems are designed to earn trust. But trust is a cumulative process, where past successful actions can contribute to achieving a higher level of

trust. Conversely, failures in one part of the market can spillover to other market segments. If IPPM systems are here to stay, then it may not be enough to rely on independent systems.

# Chapter 5

# Implications of identity preserved production and marketing for the Canadian agri-food sector

## 5.1 Introduction

This chapter offers an assessment of how IPPM could influence the role of the state, the biotechnology industry, producers, grain handlers and export markets, concluding with an attempt to consolidate the discussion into how the Canadian agri-food sector can respond to current and future demand for greater product differentiation.

## 5. 2 The role of the state

Identity preserved production and marketing systems offer a way out of the regulatory morass precipitated by the recent introduction of GM foods.

The regulation of products created via biotechnology is the responsibility of Health Canada and the CFIA. Through the Canadian Food and Drugs Act, Health Canada oversees the regulation of foods, drugs, cosmetics, medical devises and pest control products. Using the Novel Foods Guidelines the CFIA is responsible for plants, animal feeds, fertilizers and veterinary biologics. Recently the Office of Food Biotechnology (OFB) has been established within the CFIA to co-ordinate the safety evaluation of novel foods. All safety assessments are conducted based upon scientific principles developed through expert international consultations with the World Health Organisation (WHO), Food and Agriculture Organization (FAO) and the Organization for Economic Co-operation and Development (OECD) (Harrison, 2001).

All novel trait products, prior to receiving registration approval, are thoroughly tested by Health Canada and CFIA officials using scientific principles. Officials from both departments work together on a new variety application. Up to 50 different officials may be involved over the course of the application process, which takes on average 18 months to complete. These officials do not redo all of the scientific experiments and research information that is submitted by the applying company, rather they analyze all of the data that is submitted and may redo portions of the experimentation to corroborate results. Frequently, the government officials will ask the submitting company to provide them with additional information regarding specific segments of the application, which may result in the company conducting additional scientific experiments. Upon the review of all information, the variety is accepted if all conditions are fully met and rejected if any condition is not deemed to be acceptable.

The problem that many both within and outside the grain industry have with this process is that Canadian regulators do not consider socio-economic factors during the approval process for new crop varieties. The regulatory process for HT canola clearly documents this case. The process began in February 1995 when the Pest Management Regulatory Agency submitted recommendations for approval for two varieties of HT canola to the Expert Committee for Canola (this followed three years of regulatory review for feed, food and environmental safety). The Department of Agriculture, which oversaw the Seeds Act (this responsibility has since devolved to the CFIA), approved the two varieties in March 1995. Once the new varieties were

registered under the Seeds Act, the product was fully licensed to be grown and enter the grain handling system, which implicitly includes exports. The CFIA did not have any authority to require the owners of the varieties or the canola industry to segregate the new varieties from traditional varieties.

Early in 1995 the Canola Council of Canada asked the Expert Committee for Canola to delay making recommendations for future registrations of genetically modified canola until such time as the developers could demonstrate that the product had regulatory approval in the defined market (i.e. Canada, US and Japan). Canada and the US had already approved the licensing and importing of all proposed GM canola products, but Japan was in the process of developing regulatory policies and unable to decide as quickly. Given the limited legal authorities, the Canadian regulators were not able to respond to this impasse. Herbicide tolerant canola was deemed to be equivalent to existing canola varieties and no restrictions were placed upon its approval.

As a result, the canola industry voluntarily came together in late 1995 to discuss the concern that the major canola importing countries had not yet developed guidelines for importing GM products. The result of this discussion was a voluntary agreement between the seed, grain and processing companies to co-operate to segregate the 1996 production (the limited 1995 production was for seed purposes only and did not enter the handling system). This agreement respected the Canola Council's request that products from these fields not be allowed to reach international markets until the appropriate national regulators approved imports of GM products.

Because the CFIA had no legal authority to rescind (or restrict) the approval of HT canola, Canada's canola export market to Japan was jeopardized. It is possible to document the cost to the canola industry had they lost the Japanese canola market. In 1996-97, canola exports to Japan counted for 37% of Canadian canola production or 1.86 million tonnes (Smyth and Phillips, 1999). The average price for a tonne of canola in 1996-97 was $393 (SAF, 2000), which would mean that had the Japanese canola market been lost for that crop year, the canola industry would have experienced a loss of $731 million. The total cost of the IPPM system that was established for the 1995-96 and 1996-97 HT canola crop ranged between $3.55-$4.43 million or 0.5% of the potential lost Japanese canola market. It is important to note that this canola would have flowed into other canola markets, presumably at a discount, and the net financial loss would be offset by these sales.

Because the CFIA had no legal mandate to control HT canola once they had approved it, their decision could potentially have cost the canola industry significantly revenues. In this instance it was only the initiative of the canola industry acting in co-operation that averted this market problem. Federal government regulators now face the same problem that they did six years ago, namely the introduction of HT wheat into a marketplace that clearly is not presently prepared to accept this variety. To date, ten import markets have clearly expressed to the Canadian Wheat Board that they have no intention of importing HT wheat (Kuntz, 2001). The top three of these import markets, Japan, Algeria and the UK account for 20-25% of total Canadian wheat exports. Regulators are being pressured by the wheat industry to take these factors into account prior to approving HT wheat, but the CFIA has routinely stated that it possesses no mandate to include these factors in its analysis.

## 5.3 Impact on ag-biotech firms

Identity preserved production and marketing offers biotechnology two immediate benefits and one possible long-term advantage.

First, while it is evident that the use of IPPM systems will be expensive to operate in the initial stages, these cost increases must be balanced against any expected or realized gains. Although the research/seed companies may have lost some money due to the costs of the IPPM systems, they gained significantly in terms of market adoption (Table 5.1). It is very likely that if Monsanto and AgrEvo had introduced GM canola without IPPM systems, farmers would have shunned the new seeds. So the only real choice for early and aggressive adoption was to pay for IPPM systems. In this case one could argue that the two companies accelerated adoption by at least one year, which was estimated to have a net present value in 1995 of more than $100 million. Clearly, the IPPM system for HT canola directed to Japan was a win-win situation.

**Table 5.1: Net present value of earlier adoption of new canola technologies in Canada**

| Year | % acres in GM canola | | Revenue impacts of one year delay in introduction assuming $15/acre benefit ($M) | | | |
|---|---|---|---|---|---|---|
| | Actual | Delayed | Actual | Delayed | Absolute Difference | Net present value in 1995 of difference |
| 1995 | 1% | | 2.0 | 0.0 | -2.0 | -2.0 |
| 1996 | 4% | 1% | 5.3 | 1.3 | -4.0 | -3.6 |
| 1997 | 33% | 4% | 59.6 | 7.2 | -52.4 | -43.3 |
| 1998 | 44% | 33% | 89.3 | 67.0 | -22.3 | -16.8 |
| 1999 | 69% | 44% | 143.9 | 91.7 | -52.1 | -35.6 |
| **Total** | | | **300.1** | **167.2** | **-132.9** | **-101.3** |

Sources: GM adoption rates from National Research Council, (1998); Canola Council of Canada, (2000) for acreage; discount rate is 10%; and authors' calculations.

Second, IPPM offers biotechnology firms another means to protect their investment into new technology crop developments. The problem with the current package of intellectual property rights (IPRs) is that they do not fully control the use of a new technology once it is expressed in seed. Most GM crops can be propagated in subsequent years with seed from previous years. While regulations and private contracts attempt to manage that activity, many in the industry note that they are far from effective. Officials from Monsanto have estimated that without their Technology Use Agreements (TUAs), they would lose as much as 25% of the royalty payments for open-pollinated Roundup Ready™ crops; even with the TUAs, they estimate that 10% of the acreage planted to Roundup Ready™ crops are not covered by agreements and do not involve royalty payments. Moreover, industry sources estimate that in Saskatchewan alone, more than 300,000 acres of wheat in 2000 were planted to unregulated plant varieties and that 3%-5% of the exports by volume are composed of some varieties that have not been approved for release in Canada.

Third, IPPM offers a more effective tool to communicate with the rest of the supply chain and consumers about their product. This should over time help the biotechnology industry develop and introduce varieties with novel traits that have ready market acceptance.

## 5.4 Impacts on producers

Agriculture arguable is in the midst of the largest transformation since the movement from horses to machinery, and IPPM systems offer a means to manage that transition. With government support declining and markets become increasingly competitive, producers need to become proficient in more areas that ever before. Farming is only going to get more complicated in the coming years with the introduction of new crop varieties and the associated technologies to control them.

In one sense, on-farm quality assurance (QA) systems are essentially nothing more than small scale IPPM systems, facing the same challenges and issues of all IPPM systems. The biggest change that can be expected with the increased use of IPPM systems is the introduction of on-farm QA systems. Many of the new generation GM crops will be required to be grown within confined parameters. Examples of these parameters are: mandatory buffer zones; regular use of pedigreed seed; production contracts; and tolerance levels for co-mingling.

Related containment regulations can make adoption of new crops expensive and possibly prohibitive. Many producers only adopt new crop varieties after watching a neighbour have success with that variety. A common practise for producers in Western Canada is to seed 80 acres of a new variety as a test before fully adopting the variety. When Monsanto and AgrEvo introduced their HT canola varieties, they did so with 80 acre production contracts as they believed this was the most economical method for producers to evaluate the new technology. With increased use of buffer zones to control cross-pollination, the potential to introduce new crops in this manner may be drastically reduced. If the StarLink™ buffer zone of 660 feet is used as a base, this entirely removes the option of 80 acre production contracts as the buffer zone consumes the entire 80 acres. Moving to 160 acre production contracts is still very restrictive, as 76% of the land would be consumed in the buffer zone. Producers would be required to plant 40 acres in the center of a quarter section, a sub-optimal evaluation size, and plant 120 acres to a crop that provides sub-optimal rent. The mandatory requirement of buffer zones may have a negative impact on the adoption rates of not only new GM crop varieties but non-GM varieties as well.

On-farm QA systems should also increase the use of registered or pedigree seed. Some private IPPM systems already require the use of pedigree seed. Producers involved in the Warburtons IPPM system, for example, are required to plant pedigree seed each year that they are involved in the program (Kennett, 1997). The use of pedigree seed, which is allowed to have a maximum of 0.25% co-mingling of like varieties and 0.25% co-mingling of other varieties, is designed to keep co-mingling to a minimum. On average, only about 20% of wheat acreage seeded in Western Canada uses purchased seed; the rest is farmer-saved seed.

The use of production contracts will also rise with the increased use of QA systems. Numerous issues can be addressed through production contracts such as crop rotation, buffer zones, use of pedigree seed, and specific planting and harvesting requirements. Monsanto and AgrEvo both used production contracts to introduce HT canola while many of the speciality crops grown in Canada are done under production contract. There are both benefits and risks associated with the use of production contracts and producers will have to determine which contracts are best for them, which will increase the need for management education and good solid market information.

Some recent research by the Canola Council of Canada (2001b) suggests that producers in Western Canada are already well positioned to be able to identity preserve grains and oilseeds on-farm. The Canola Council study found that of the producers that grew both HT canola and conventional canola, 72% binned the two varieties separately, even though there was no requirement or financial incentive to do so.

On-farm QA systems will require much more than separate binning. Producers will have to become their own managers of quality. Farmers will have to begin to test their crops at all stages of production and handling. Producers will have to test and retain samples of the seed they plant to ensure that any level of co-mingling tolerance is not jeopardized on farm. If a crop is planted and tests come back that show there is a co-mingling problem, the producer will have to decide whether to destroy the crop or find an alternative (feed use) market that will be able to accept the commodity, without jeopardizing conventional grain handling systems. Testing will also need to take place at the time that the crop is binned. This will determine the level of purity after all instances of cross-pollination and mechanical mixing have occurred. When the commodity is delivered to the purchaser, who will take samples of their own, the producer also may want to take samples to ensure that any liabilities are not misdirected. While no clear cases have been examined, the potential exists for some liability to be placed on the producer if a co-mingling violation could be traced back through samples to a specific elevator. The retention of seed samples by producers may be essential insurance in case such a situation arose. A producer that retains a sample that is tested by a thorough testing system may be able to insure the farm operation from any liability claim; those who fail to manage their own quality may have no way of documenting that their production was not at fault. Regardless of the reason for testing, farmers will need tests that are quick, simple and accurate to be successful, but the technology has not yet caught up to the needs.

### 5.5 Impacts on grain handlers

Identity preserved production and marketing will have by far the largest impact on the grain handling industry. The difficulty right now with testing all incoming grain and oilseeds is that even the quickest tests take 5 to 15 minutes to produce results. While normally this would not be a problem for the elevator or the producer, it would be a serious challenge during harvest. Elevators currently take in more grain during the average six to eight week period that covers most harvests than during any other time in the crop year. Neither producers nor elevators can afford to sit idle for 5 to 15 minutes at that time and wait for test results. One suggested solution is to have all grain stored on-farm after harvest and have the producer provide a sample from the bin to the elevator for testing. If the sample is acceptable, the elevator would call in the grain as required. This would require producers to increase their ability to store grain on-farm by adding additional storage space. This scenario is not ideal, some solution must be found.

Even if the simple logistics can be sorted out, the grain handlers face the complication that new varieties are being introduced regularly and they have variable acceptance in export markets. Grain handlers have expressed concerns about their ability to prevent or to manage varieties that have not been approved for import by all potential buyers from being co-mingled. This has already had consequences. In May 2001, Monsanto, Saskatchewan Wheat Pool and Agricore withdrew Roundup Ready Quest™ canola seed when they discovered it contained a trace amount of a genetic transformation event that has yet to be approved by the EU. The three

companies had to inform over 3,000 producers about the recall. Some of the canola had already been planted and had to be ploughed down as this was the only method of control remaining. The StarLink™ issue has shown the world the cost of not properly containing varieties that are not approved in all markets.

While testing for GM content will be a major logistical issue for grain handlers to deal with, the issue of potential liability resulting from contamination may be the most financially damaging. Elevators are designed to be self-cleaning, meaning that most of the grain is removed when a storage crib is emptied. When faced with a GM tolerance level of 1% or less, removing only most of the grain from the crib may not be adequate. All the grain may need to be removed. Doing this requires an employee entering the storage crib and physically ensuring that all kernels of grain or oilseed are removed. It is not a difficult process, but is time consuming. This method is currently the only possible option for grain handlers when faced with handling GM and non-GM commodities to be certain that they are not creating future liabilities.

The grain handling industry will have to be very diligent in its approach to handling IPPM products at low tolerance levels. Grain firms face the possibility of being liable for large volumes (e.g. an entire boatload of grain) if they are not diligent enough in their approach to preventing co-mingling. While this cost would be significant in itself, the loss of reputation would be most damaging. Any grain handling firm that has an IPPM system in place and has a co-mingling event occur will lose some of their ability to successfully market themselves to foreign buyers as having the track record to prove the can properly segregate.

The ability of grain handlers to move grain and oilseeds at very low tolerance levels will severely strain the present grain handling system. While the industry is investing in high throughput elevators, the market may actually require smaller unit elevators (perhaps based in the old wooden buildings) that have sophisticated cleaning and handling processes. The grain industry is incredibly competitive and it is doubtful that any one grain firm will abandon handling GM commodities to preserve non-GM commodities. Having said that, it is not clear how the current industry will move to meet new market needs.

### 5.6 Export markets

Identity preserved production and marketing has significant potential to work with the Canadian regulatory system to secure and capitalize on our current market position.

The CFIA is facing mounting pressure regarding the anticipated introduction of HT wheat in the next 2-4 years. Already foreign export markets such as Europe and Japan have explicitly told Canada that they will stop importing Canadian wheat if HT wheat is allowed to be introduced into the marketplace without an IPPM system. The CWB has taken the position that since the major export markets for Canadian wheat are not expressing an interest in purchasing HT wheat, there is no reason to introduce this variety of wheat into the marketplace at this time. The CFIA has responded to the initial concern of cross-pollination of HT wheat with conventional wheat varieties in test plots and has increased the buffer zone from 10 meters to 30 meters (CBC, 2001). Monsanto is entering the fourth year of test plots with HT wheat and have not detected any cross-pollination outside of these test plots.

Canada has a real opportunity to build upon its international reputation of being a country that is trusted to segregate and quality assure crops. The introduction of HT canola

highlighted how this could happen. The key to that effort was the role of the Canola Council of Canada, which worked with grain exporters, regulators and importers in Japan to convince them that Canada was segregating GM varieties and that problems would not arise in export shipments. Both Monsanto and AgrEvo officials admit that the Council played a vital role in providing the Japanese with the assurances that Canada could and would segregate, which assisted the Japanese to continue to import while the new varieties were under review. This mutually beneficial arrangement contributed to IPPM policy having greater legitimacy in the eyes of Canada's key canola export markets. One of the primary reasons that the Japanese had a large degree of *ex ante* trust in the Canadian IPPM system was that it was built upon a 20 year relationship. Beginning in 1977, the Canadian and Japanese industry began annual consultations on crop quality and quantity (Adolphe, 2000); these consultations became biannual in 1987. The Canola Council over the years convinced the Japanese that Canada has a credible variety registration system that prevents new varieties from being released without first being approved by industry and government. The lengthy working relationship and understanding of the variety registration system allowed the Japanese to trust that the Canadian canola industry could segregate GM canola and did not demand any additional insurance clauses or right of inspection or testing.

The canola example suggests that privately led, IPPM systems can both work with and bolster the internationally respected Canadian regulatory system in order to protect Canada's export markets for grains and other commodities when faced with the introduction of new GM varieties.

## 5.7 Overall impacts on the Canadian marketplace

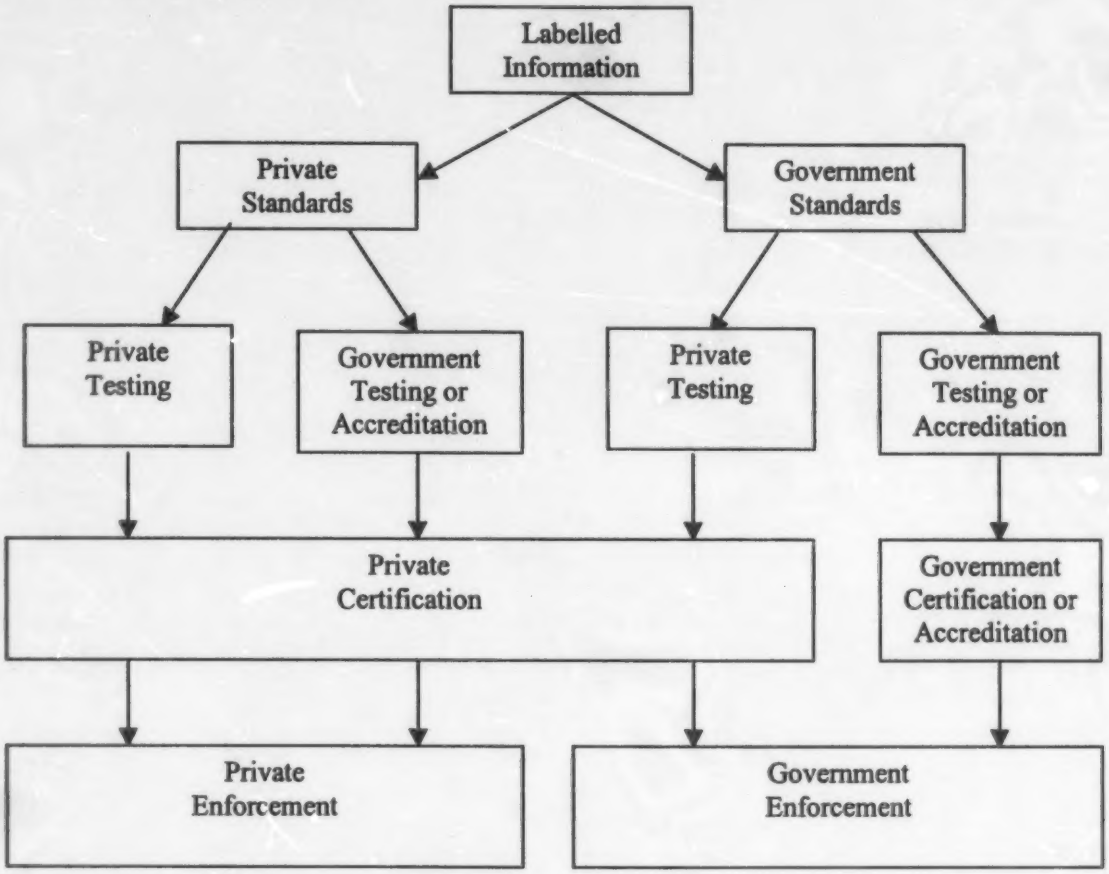
The impacts of changing regulatory requirements vary depending on who implements the new regulations, the public sector or the private sector. Presently, the Canadian government has adopted a position of co-operation with industry to allow them to be fully involved in the process of creating and establishing new regulations.

The area of labelling and testing for IPPM systems will likely become the key point of contention between governments and private firms as they seek to manage consumer concerns about biotech products. Canada is presently involved in the Codex discussions on voluntary labelling standards however, mandatory labelling requirements may soon become a reality at least for exports, if not for domestic consumption.

Figure 5.1 presents the options available to industry and government when considering how to address the issues of increased consumer and regulatory pressure to label and test for GM content. If the ag-biotech industry seizes the initiative and decides to address this issue prior to the regulators, then they will be able to follow the first or second flow lines, using private standards to provide information to consumers. One option would be for the ag-biotech industry to establish private industry standards for labelling and to establish private mechanisms to test, certify and enforce the labels. While this process might provide the industry with standards that are most cost-effective, it might not completely meet the information demands of the consumers. This then could lead to a hybrid where the government or an agency of the government is involved in testing but the rest of the system relies on private initiative. An example of this is how the CGC tests and certifies all grain and oilseed exports from Canada. The concern with the private labelling approach, however, is that the chain will only be as strong as the weakest link.

It only takes one firm not fully meeting industry requirements to jeopardize the entire system structure. The inability of one firm to take into consideration the investments and responsibilities carried on by other firms can financially impact the rest of the industry (e.g. Aventis and the US corn industry).

**Figure 5. 2 Labelling flow-chart**




Source: Modified from Golan, *et al.*, 2000.

The other option is to have government regulators take the initiative and draft regulations and then either with or without industry's approval, implement and enforce the new regulations. While this method would likely cost the industry more, it could provide consumers with the level of information that meets their needs. When government regulations are implemented, there is often a higher level of trust than with industry standards.

There are trade-offs to be had with either path taken. Whichever path is ultimately taken, it must be remembered that the main concern in the consumer marketplace today is that of quality and trust. Ultimately, quality is based on trust. Consumers recognize that a product has the desired quality because they trust the producer to continually provide products that are

consistent with what is promised. Industry standards or government regulations will need to strive to have this as the focal point of any new initiatives.

## 5.8 Conclusion

Lehnert, *et al.*, (2000) make the point succinctly:

> Failures occurring during the establishment of a new product or a new process cause high correction costs. They may often lead to losses of market share and damage to the image of the supply chain. It is therefore reasonable to pay attention to potential failures in the early stages of establishment and process planning.

This lynch-pin concept defines a new approach required for the introduction of new GM crops: do no harm! Caution, diligence and concern for others must be the leading motto for all participants in IPPM systems. In the past, the focus has been to introduce new products and make adjustments as one went along. That strategy clearly has not worked. Industry now needs to identify and learn from the difficulties, successes and failures that occurred with the introduction of GM canola, corn and soybeans and make sure that they are not repeated with the introduction of new GM crops.

IPPM offers opportunities to manage risks, administer benefits and communicate about impacts of new crops. Product differentiation offers benefits that are too significant to lose. The benefits of moving toward an increased use of IPPM systems would seem to outweigh the concerns or logistical problems that would be created. As with most technology advancements, it is the early adopters that benefit the most. The increased use of IPPM systems is a technology advancement that is no different from other technology advancements, and should be approached as such. If the province of Saskatchewan, and indeed the whole Prairie region, were to rapidly adopt the use of IPPM systems, it would provide a new vision, direction and market-directed focus for an industry in search of a future.

# Concluding observations

This review of the theory, literature and practice of IPPM systems in the agri-food system offers a number of points for researchers and practitioners to consider as they examine or develop IPPM systems:

1. Never before has the marketplace placed such great emphasis on food safety and other quality attributes. This has resulted from endemic food scares and the inability of some domestic regulatory systems to prevent contaminated products from reaching store shelves. Consumers are increasingly demanding new information and greater details regarding the growing and processing of food products. Conventional supply chains, such as those for grain and oilseeds, are having a difficult time adjusting to these new demands for information and as a result producers continue to grow those products they are familiar with rather than the products consumers want. A paradigm shift is required by those involved in prairie agriculture to allow the supply chain for grain and oilseeds to produce the products that consumers are demanding.

2. New and more sophisticated technologies are increasing the capacity to develop and introduce new processes and new products with distinct and differentiable traits. The potential appears almost limitless, as private capital seeks to do for food what it has already done in many other consumer directed sectors. The need to rapidly adapt and adopt these products into the market will increase the pressure on both public regulators and private supply chains to ensure safety and quality.

3. Within the past three years over 25 nations have pledged to adopt labelling legislation regarding the content of GM ingredients. While very few of these nations have actually enacted labelling legislation, most are moving forward to do so. As more and more nations establish defined labelling legislation, Canada will be forced into deciding which export markets will be a priority to maintain. To ensure that these markets continue to purchase from Canada, IPPM systems will have to be established to provide confidence to foreign importers.

4. The introduction of more new value-added crop varieties and increasingly choosy consumers will likely drive prairie agriculture to develop more and better IPPM systems. While the estimates vary, all observers believe that the market share for identity preserved products will increase substantially, possibly up to 25% to 35% of total production over the next five to seven years. Commodity driven, pooled production will increasingly be viewed as yesterday's technology and those that continue to adhere to this concept will find themselves excluding from an increasing number of markets.

5. The introduction of the world's first IPPM system to segregate a GM crop (the Canadian experience with HT canola in 1995-1996) was viewed as a success by both the domestic industry and foreign markets. The efficient and effective operation of this IPPM system has fostered enhanced trust in the Canadian grain handling system in the eyes of foreign markets, mainly in Europe and Japan. It should be possible to market this success and the trust it created to the global grains, oilseeds and pulse markets.

6. One of the leading concerns of the new biotechnology derived crops is the management of risks and liabilities associated with these new crops. IPPM systems can provide an effective and proven method of controlling risks and liabilities. When properly structured and carefully administered, IPPM systems are capable of operating at a purity rate of 98% to, in some instances, over 99%. However, IPPM systems that are not properly structured and are poorly administered, such as the system initiated by Aventis to manage StarLink™ corn, can have a detrimental impact on the entire industry for that product. The key to ensuring that IPPM systems can operate effectively is to have a realistic tolerance level in place for adventitious and accidental co-mingling. Within any IPPM system mistakes are going to occur, and when they do the system must have the flexibility to be able to continue operating while the source of the undesired co-mingling is determined. Furthermore, there may need to be some insurance mechanism put into place to compensate producers, in particular, for adventitious co-mingling. This could be regulated and administered by the public sector or developed and funded by industry.

7. While most existing IPPM systems are designed to capture premiums in the market, they also offer significant potential to manage environmental risks and product liability. While IPPM systems have been designed to control the technology in the short term (i.e. one growing season or crop year), there is potential they could be used to manage multi-year environmental risks. With biotechnology firms aggressively protecting their intellectual property when infringement is discovered, an onus of responsibility is justifiably created when the unintentional presence of this property is discovered.

8. We need a better understanding of how IPPM systems can be better structured to evolve and adapt to market needs.

- The feature that is synonymous with the rise in IPPM systems is the increased use of production contracts. Seed companies offer production contracts to producers through grain handling companies, who in turn have production contracts with processing firms. The use of production contracts for value-added GM crops will become increasingly commonplace in prairie agriculture. More needs to be learned about how these contracts work and how they distribute benefits and costs.

- It has been shown that the cost of operating an IPPM system is not cheap, most of the actual operating IPPM systems are showing cost increases in the range of 15%-20% above the cost of conventional supply chains. The problem with these documented IPPM systems is that the volume handled is at such a low level there is little confidence in the accuracy of these numbers; most believe the true cost to be much higher. If IPPM systems are going to succeed, they will need to become more cost effective.

- Some elements of the currently mostly private IPPM regimes will need to be collectivized to lower costs and ensure credibility. In particular, this could involve organization and training for on-farm quality assurance systems. On-farm QA will necessarily involve setting standards, records keeping and audits. This will require farmers to make more sophisticated use of financial instruments, make new investments in logistics equipment, invest in more training to ensure agronomics and quality systems function appropriately. The most significant change that will come with the increased use of IPPM systems, as it relates to Saskatchewan agriculture, is

that farming will become more of an integrated business. Producers will need to learn how to maximize their return on investment in order to compete successfully in this rapidly changing marketplace. Federal and provincial farm programs and industry could assist with this transition.

- While production, marketing, transportation and handling systems are going to have to be radically restructured in Canada to enable producers and firms in the grain industry to compete in this market, existing institutions offer a solid base to build upon. Identity preserved production and marketing systems stand the best chance of success if they build upon credible and trusted institutions and relationships in the market (e.g. Canola Council of Canada; Canadian Wheat Board; Canadian Grain Commission; and major grain companies).
- IPPM systems are only as strong as their weakest link. In absence of regulatory action, collective efforts must be made to assure all IPPM systems deliver what they promise. This involves establishing standards and credible, third party audit systems. As testing for co-mingling grows, the industry or government may be able to assist by establishing a testing kit registry to ensure that test kits actually work.

9. More research is needed to evaluate effectiveness of supply chains that extend beyond farm-gate and especially into international markets.

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